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LINGUISTICS.—*Phonematic daylight in Lhiinkit, Navajo of the North.*[1] JOHN P. HARRINGTON, Bureau of American Ethnology.

If one were asked to enumerate the most outstanding native American languages, Aztec, Maya, Quechua, and Guaraní could be mentioned, and No. 5 could well be the Lhiinkit of North America, famous tongue of what is now southeastern Alaska and true closely related mother of the Navajo language spoken by North America's largest tribe. Lhiinkit is the Indian language that prevailed at Sitka, formerly Russian capital of Alaska, and at Juneau, present-day capital. Lhiinkit war canoes roved from Yakutat Bay in the north to Puget Sound in the south. The writings of the widely mentioned Veniaminoff and also standard modern Russian have Kolósh, Lhiinkit native, Kolóshi, plural, and it was from an aberrant form of this, transmission through German being apparent in the sch, that Powell, in part following Gallatin, published in 1891 "Koluschan" as his adoption for the stock consisting of the Lhiinkit language, which stock became revealed clearly by subsequent study as genetically related to the Skittagetan (Haida language) and to the Athapascan (including Navajo) linguistic families set up by Powell in the same pages. The word łiinkít is Lhiinkit for person, that is, Indian, and has been spelled in various ways, especially as Tlingit, the local pronunciation among the Whites being always Clingit, and the Russian name for the language and tribe having stuck in English not at all.

The Lhiinkit tribe was first discovered by Chirikof in 1741, whose ship got separated from that of Bering. A Russian fort was built in 1749 at Sitka, whose name means on the seaward side of Baranof Island. In 1802 the Lhiinkit Indians threw off the Russian authority at Sitka, only to be reconquered again in 1804, Sitka subsequently becoming the Russian capital of Alaska. The entire Lhiinkit region was acquired by the United States through purchase from Russia in 1867.

The Lhiinkit Indians are supposed to have numbered about 10,000 at the time of their discovery; their population is at present less than half that number. They represent the typical focus of Northwest Coast culture. They are bifurcated into raven and eagle moieties and have matrilineal descent, as depicted in totem poles and otherwise.

Fresh from the study of the Navajo language of the southwestern United States, I pried into the Lhiinkit language for genetic relationship with Navajo, and found it, amounting to practical identity in sounds and structure and lexical co-inheritance extending to some 400 vocables. Exactly like Navajo, Lhiinkit operates with a high and a low accent, and rarely both of these accentuations are to be found in one and the same Lhiinkít morphom, for instance Lh. łú, łù-, nose. Coming to comparison of consonants, these like the vowels show much discrepancy in their appearings, to such an extent that at this stage of the study comparative presentation of shifts can not well be made. Thus Lh. thè, stone, is patently the same word as Nav. tshé, stone, reminding one of such changes as are found in Quechua dialects, while Lh. khèł, dog, Nav. łį́i', pet, reflect some ancient metathesis. In order correctly to understand correspondences, one would have to know the ancient development of forms, which lack of record forever deprives us of knowing.

[1] Received August 29, 1944.

Anyone who might look into the Lhiinkit, Haida, and Athapascan languages at all would see the thorough resemblance, and Boas early observed and reported on this resemblance. Sapir[2] later united these stocks, calling them "Na-dene." This discovery was not followed up by Sapir, at least not with further publications of comparison. Contemporaneous with Sapir's article, Boas worked with Shotridge, a Lhiinkit-speaking Indian employed by the University Museum, Philadelphia, and published as the result his "Grammatical Notes on the Language of the Tlingit Indians."[3] In this paper Boas sets forth sweepingly and definitely for the first time that Lhiinkit has as its accentuation preeminently high- and low-pitched syllables, which later proved to be true also of Navajo and is the case with many languages. Also he gave much better presentation than had been given before of sounds and elements of Lhiinkit.

Boas studied with Shotridge the Chilcat dialect of the northern mainland. I studied the Prince of Wales Island dialect, that of the southwesternmost large island, and the illustrative forms given below are all from this dialect. The dialects of the Lhiinkit language differ to a comparatively slight degree from one another.

The prime essential to comparative work is that if possible the languages to be compared should be studied by one and the same individual. Studying Lhiinkit fresh from Navajo, I enjoyed an advantage in having both languages in mind. It is to be regretted that structure follows mastery of sounds, and that the limits of the present publication prescribe a dealing only with the sounds. The main purpose of this paper[4] is to present the constituent sounds of Lhiinkit. As in all other languages, these sounds fall into vowels and consonants.

Vowels

The Lhiinkit vowels as regards quantity are only four in number: a, u, e, i. These are exactly the four vowels of Navajo. It is the Lhiinkit lack of o that makes the native say, for instance, fúum instead of foam when talking English. The vowels are appositionalized as shorts and longs, the former tending to take on the secondary feature of centralized quality. Nasalized counterparts of these vowels have arisen in Navajo, mainly through the eating into the vowel of a syllable-closing nasal consonant, but nasalized counterparts do not occur in Lhiinkit.

The short vowels of Lhiinkit are, of course, as short as it is practical to pronounce them and tend toward being centralized or obscured, while an adjacent consonant can sometimes be detected as having an influence; for instance, the sequence wa in Lhiinkit has regularly the a-quality of English water. In fact, an a in Lhiinkit has in certain instances a labializing effect on an immediately following consonant. Thus Lh. híinnà-k'w, (1) a little water, (2) a drink of water, is the diminutive of the word for water, yet for instance tù-yyíit-k', his little son, diminutive of son with possessive pronoun, has its -k' unlabialized. The long vowels of Lhiinkit and of Navajo can well be written by doubling, just as has been practiced by Thalbitzer in writing Eskimo and is recommended by high authority for the writing of African languages.

QUALITY VOWEL CHANGE

The Lhiinkit language has three quality ablauts of its vowels: e versus a, e versus ee, i versus ii. These are illustrated by the following:

thè, stone; thà-yyìis, wedge.
cé, blood; ìi-ccée, it is bleeding.
'à-kk'íi, my buttocks; hàstù-kk'íi-x', dpl. their buttocks.

VOWEL DIPHTHONGS

In Lhiinkit vowel diphthongs are heard clearly and easily to consist of a short or long vowel plus ww or yy. The second element of the diphthong always tends to be held, but is often very centralized. The consonantal character of the second element is brought out when the preceding is of the

[2] Sapir, Edward, *The Na-dene languages, a preliminary report.* Amer. Anthrop. 17: 231–266. 1915.
[3] Boas, Franz, Univ. Pennsylvania Anthrop. Publ. 8(1): 1–179. 1917.
[4] The use of the term "daylight" in the title of this paper is in keeping with the widely known Lhiinkit myth that Raven let loose the daylight for the people.

same general quality. The following words exemplify vowel diphthongs:

'áyy, interjection of disgust.
t'áaww, feather.
nèyy, listen!
ł'éeww, sand.
'úww, ouch!
'úuww, buy it!

PITCH

There are in Lhiinkit, just as in Navajo, only two accents, which can also be spoken of as pitches or tones: high and low. This feature has already been set forth above, but deserves remention here as in proper place, since it concerns primarily vowels and vowel diphthongs.

Sometimes the accent distinguishes what would otherwise be homophones. Thus:

X'úun, fur-seal; X'ùun, fallen-tree.
'íi&, out at the beach; 'ìi&, (1) copper, (2) soldering-iron.
Xáayy, yellow cedar; Xàayy, sweathouse.

Words of most different meanings are as often exact phonetic homophones. Thus:

'áa, (1) lake, (2) he is sitting.
thàan, (1) sea-lion, (2) navel cord.

Boas states that many postfixes put in appearance as high and as low, this being brought about by the postfix taking a pitch the opposite to that of the base to which it is attached, but Boas gives his finding of only two: -yí, -yì, possessional, and -tée, -tèe, to. And I have been able to find only these same two.

STRESS

The making prominent by loudening of the final low syllable of a coherence-group, and of certain other low syllables, is not indicated by Boas.

CONSONANTS

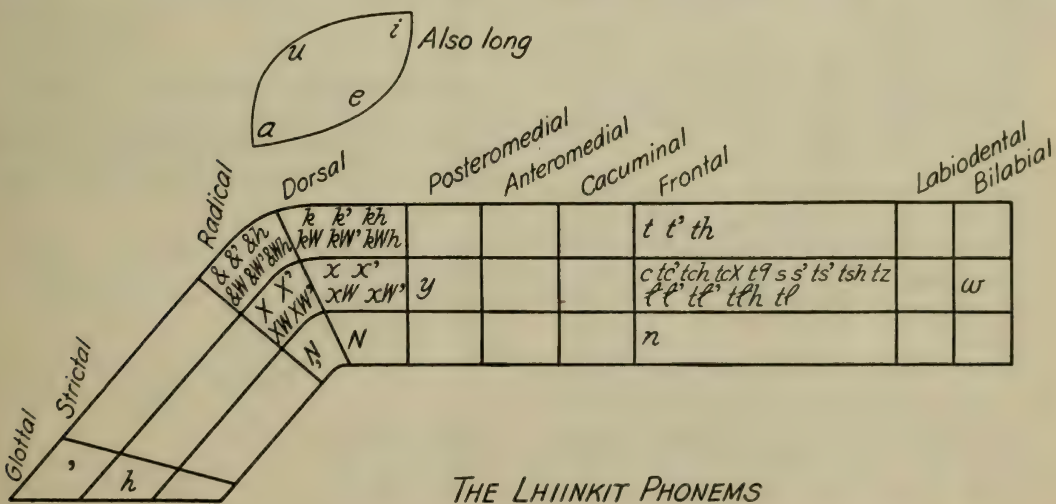
The articulative tract for producing consonants is much longer than that employed for the production of vowels, the vowel producing section being only a small central part of the long consonant tract.

The consonants of Lhiinkit are very numerous and on the whole impress one as being forceful and audible above the noise of waves and the murmurings of the forest. The buccal or mouth consonants are trifurcated into plain, clicked, and aspirated varieties, the first pronounced as in French, the second clicked like the clicked consonants of Georgian and Ethiopian, the last pronounced with a distinct h after the consonant, like Mr. Dooley's "t-hake." Lhiinkit tsh does not occur at all, but tch occurs, which has also an overaspirated by-form occurring only in one word: tcXán, grandchild (instead of *tchán).

Even y interchanges with w in the possessional. Thus -yí, -yì, when following the vowel u, certain a's, or the consonant w appears as -wú, -wù. The earlier forms must have been *-Gí, *-Gì, -*Gú, -*Gù.

A buccal clusive telescopes with alif to become a clicked clusive.

Alifized fricatives have the alif pro-



THE LHIINKIT PHONEMS

nounced after the fricative. Thus, for instance, s'.

Both unaspirated and aspirated clusives occur at the beginning of or in the interior of words, but the unaspirated when etymofinal or pausal become aspirated. ìit, room, has t which becomes by positionality aspirated, whereas 'ìith, place, has aspirated th, so one forms 'àX-'ìitt-í, my room, but 'àX-'ìith-í, my place.

Consonant diphthongs having the second member consisting of a voiced fricative, for instance kw, tz, tl, have this second member voiceless when pausal: yàakw, canoe, pronounced pausally with voiceless w. The labialized clusives of this group are of two origins: those having labialization induced by preceding sound and those labialization not having so induced; but of whichever origin they are handled exactly the same. This phenomenon is only a phase of that formulated into statement in the preceding paragraph as regards the aspirating when final of otherwise unaspirated clusives, but since one is cut from knowledge of the history of the language, it is practical to make a separate statement about consonant diphthongs with voiced last member separately.

In Lhiinkit, as in Navajo, a consonant sound between vowels within a word is lengthened or held, reminding one of yy and ww, sole second members of vowel diphthongs mentioned above, and it is the tendency in Lhiinkit and in Navajo to lengthen an intervocalic consonant so positioned by the coming together of words in the same way:

'àan, town; 'àann-í, his town.
ƚìinkít, person; 'àX-ƚìinkítt-í, my native.
yàannàahhéen, it is moving about without support (as a shadow hovers).

When any one of these words with lengthened interior consonant is syllabized, the doubled consonant resolves itself into syllable-closing h plus syllable-opening single consonant: 'àann-í, his town, syllabized: 'àah-ní.

Many of the Lhiinkit consonant clusters are single sounds, but some are caused by the coming together of two distinct sounds.

The more widely available &, X, G, Y, N, and W have been employed instead of less widely available characters for the radical clusive, the radical fricative, open g, superior y, dorsal n, and superior w, respectively. For practical orthography w can be used for W.

We next list the Lhiinkit consonants, finding them to occur produced in five articulatory positions.

GLOTTAL

'

The apostrophe is here pressed into service for indicating the sound produced by the closure of the glottis or vocal cord chink, which sound is known in Arabic grammar as alif, or more precisely as hamsated alif. In Lhiinkit, just as in Arabic, no word begins with a vowel, but an etymoinitial vowel is begun with an alif, a procedure that in the language of singing would be termed a hard attack, and that can be well compared to the teeing of a clarinet at the beginning of each note; it need not be written, but since it is becomes prominent as a "hiatus" when a word ending in a vowel precedes, it is best written. a', being a consonant, is treated like any other consonant and between vowels becomes doubled.

'àan, village.
wà''é, you.

The colliding of alif with a clusive produces the clicked variety of clusive, for instance, t', the mouth closure smacking against the glottis closure with the result that the t becomes clicked or clucked.

h

The other glottal consonant of Lhiinkit is h, pronounced practically as is the h of English. Lhiinkit has h in addition to X and x, and not only in interjections but in other words as well:

hàaww, well!
'ùhhàan, dpl. we.
hàstù-, dpl. their.
'ìh-wáa&, your eye.

RADICAL

&

&án, firewood.
&àkkàan, sun.
s'ìi&, smoke.

&'

tháa&&'àa, mosquito.
t'ìi&', ice.

&h

&hà, and.
&háa, man-in-prime.
&hù, to go in a canoe.
tà&&hàan, dpl. they are quarreling.

&W

Found in the material to occur only in &wáattlàn, Portland, and this is suspected to be more properly &wháattlàn.

&W'

&W'àn, to dry salmon.

&Wh

&Wháan, person of a place.

X

Xàt, I.
Xàat, root.
XùX, husband.

X'

X'àan, fire.
CthàXX'ìin, Stikine River.

XW

XWàaXXás', I mended it with roots.

XW'

No sure example can be found.

N̥

'àN̥&háawwù, rich-man (assimilated from 'àn&háawwù).

DORSAL

k

kùut9, hill.
nìik, news.

k'

k'ìssàannì, group of youths.
'àtk'àhhìin, believer.
tc'àak', bald eagle.

kh

kháat', digging stick.
khèetl, dog.
Cìikkhá, Baranof Island.

kW

kWàł, to hit with the fist.
tłhákw, always.

kW'

kW'at', egg.
'ankW', cry baby.

kWh

kWhéeyy, mark.

x

xàas, horse.
Ts'uutxxàn, Tsimshian person.
t'èex, fishhook.

x'

This is perhaps the most difficult sound of the language, for those who are not native speakers, to make quick and approximately correct adjustment for. Perhaps to make the sound more distinct from X', almost xY' is pronounced.

x'àat', island.
thàaxx'áł', needle.
théex', heart.

xW

xWèe, (1) interjection of surpressed expectancy, (2) interjection of fatigue.
yàXtìxxWás', it is hanging.
s'àaxW, hat.

xW'

xW'àał, (1) featherdown, (2) euphemistic substitute word for tàł, (1) halibut-club, (2) weight.
'ùnnànnáa-xW', dpl. inland mainland Indians.

N

łiiNkít, person (assimilated from łiinkít, which latter form is the more commonly heard form).

POSTEROMEDIAL

y

yàan, hunger.
yíit, son.

The noticing that y if made a little more fricative is GY makes it more understandable how y in Lhiinkit interchanges with w:

tù-t'áayyì, his board, but 'àX-&háawwù. my man.

FRONTAL

The most remarkable fact about the frontal series of Lhiinkit is that, just as in Navajo, tc, ts, and tł do not occur.

t

tèeX', 2.
nàttáakW, table.
Xàat, root.

t'

t'á, king salmon.
yàtt'àa, it is warm.
łít', eel.

th

thè, stone.

c

càa, mountain.
khèeccíc, alder.
'ìiccáan, pitiable.
wác, cheek.

tc'

tc'àak', bald eagle.
wùłtc'éXW', it is dirty.

tch

tchán, stink.
yàantàttchúun, (1) it is straight, (2) it is true.

tcX

This overaspirated form of tch has been found to occur only in one word: tcXán, grandchild. The commonly used form of this is always the diminutive, tcXán-k', grandchild.

t9

t9ín, hand.
'ìh-cù&&hàtt9áa, let me show you how.
'íit9, half-submerged rock.

s

síik, belt.
khìs, bracelet.

s'

s'àaxW, hat.
kùus', cloud.
&hùkkáas', fog.

ts'

'àtts'ùuts', it is jerking (on the fishline).

tsh

tshàa, hair seal.

tz

tzàas, thong.
łìttzíi, it is difficult.
ts'ùtzkW, bird.

ł

łèe', red-ocher.
khàłłìttzíi, it is somewhat difficult.
thìił, scar.

ł'

ł'úut', tongue.
'éeł, (1) ocean, (2) salt.

tł'

tł'ù, rotten.
tł'ìi, (1) finger, (2) toe.

tłh

tłhàa, mother.
-tłhén, augmentative

tl

tléet, (1) snow, (2) whiteness.
xàatl, iceberg.

n

nàa, tribe. This word is the prebase of Sapir's Na-dene, proposed as a stock name (see above); the postbase is a reflex of Nav. tinné, also tinnę́, person, Indian, and related forms following Morice's attempt to replace the term Athapascan by "Déné."

'Ànnúuccì, Russian person, said to be from Russian Rùsskiy, a Russian.

'àan, town.

LABIAL

The absence of lip sounds except w in Lhiinkit has been noticed by various observers and is regarded as a trait of superiority by the natives themselves, who feel that throat and tongue adjustments are more easily negotiable than lip adjustments. Russian and English with their full measure of lip sounds get loan-words from these languages into Lhiinkit reflexed by the nearest thing to them, which is such sounds as &W, kW. Foreign m is twisted to w. Appearance of y as w has been given above.

wát, river-mouth.
wùun, maggot.
wán, edge.
Híntt9ìtchwàan, Englishman (from this).
łéekWà, bread (from Russian xléb, bread).
&Wáattlàn, Portland (from this).

ENTOMOLOGY.—*Preliminary life-history studies in Guam of the scarab beetle* Ancylonycha mindanaona (*Brenske*).[1] R. G. OAKLEY, U. S. Bureau of Entomology and Plant Quarantine. (Communicated by ALAN STONE.)

Severe attacks by larvae of the scarab *Ancylonycha mindanaona* (Brenske) on the Island of Guam in 1937–38 destroyed many young corn plantings. The insect, probably introduced from the Philippine Islands at some undetermined time, first occurred in damaging numbers on corn in 1935, according to reports, but became of increasing importance in 1937. These destructive appearances of the beetle may have been sporadic in nature, or they may have been due to a population build-up during the years subsequent to its supposed introduction. Its future importance to Guam's major food crop is a matter of conjecture.

To determine the habits of the insect as a basis on which to attempt control measures, studies of the pest were conducted by the writer during the period from June, 1937, to July, 1939, at odd times when other duties, including the enforcement of plant quarantines, permitted. Owing to the discontinuity of these studies and lack of equipment, the results obtained can not be considered either conclusive or complete. The data acquired may be of some value to Island agriculture, however, and are therefore summarized below.

HISTORY

Ancylonycha mindanaona was described by Brenske in 1893 under the generic name *Holotrichia* from specimens collected on the Island of Mindanao, Philippine Islands. It is probably indigenous to the Philippines, where its importance is unknown to the writer, literature on the subject not being available. Dammerman (1929) reported a related species, (*Holotrichia*) *A. vidua* (Sharp), as a commonly mentioned root pest there in 1929, and Lopez (1931) stated in 1929 that a little-studied species of *Ancylonycha*, probably *vidua*, was responsible for extensive damage to sugarcane.

The presence of *Ancylonycha mindanaona* in Guam was first definitely established in 1936 when Swezey submitted specimens collected on banana leaves to the Bureau of Science, Manila, P. I., for specific determination. Vandenberg (1931) recorded "*Lachnosterna* sp." as attacking pineapple roots on Guam. It is considered possible that he had reference to the form identified as *mindanaona* by the Bureau of Science, and by Böving at the United States National Museum in 1937 from specimens collected in Guam.

DISTRIBUTION IN GUAM

Nine of the Island's 17 districts were known to be infested by *Ancylonycha mindanaona* in July, 1939, although damaging infestations of outstanding importance had been found only in the districts of Asan, Tumon, and Dededo. The thickly dotted areas in Fig. 1 represent those districts bearing the heavier infestations, whereas the thinly dotted areas in the districts of Sumay, Piti, Agana, Sinajana, Barrigada, and Yona represent localities where infestations were more sparsely distributed. Significant damage to economic crops was only rarely found in the lightly infested districts.

ECONOMIC IMPORTANCE

The economic value of crops destroyed in Guam by *Ancylonycha mindanaona* was insignificant when compared with damage inflicted by a major pest in the United States. To the Guam farmer, however, who can cultivate only a small acreage with his primitive hand tools, losses sustained from attacks of the pest on corn represented part of a season's labor and a subsequent lack of his principal food supply until a second crop could be produced 9 months later, when rainfall again became favorable. Some farmers, rather than attempt to continue cultivations and suffer crop losses, actually

[1] The writer gratefully acknowledges the cooperation of the Naval Government of Guam in supplying the excellent services of José I. Cruz to assist in investigative studies, and the kind assistance received from Dr. E. A. Chapin, curator of insects in the United States National Museum, who prepared the description of the adult in this paper, and from A. D. Cushman, who prepared the drawings. Received October 4, 1944.

transferred their farming operations to non-infested areas.

Both larvae and adults are very voracious feeders, the former attacking lateral and tap roots, the latter feeding on the leaves. In October, 1937, 10 fields of young corn located at Dededo exhibited plant losses

Fig. 1—Map of Guam showing relative infestations of *Ancylonycha mindanaona* and infested localities.

ranging from 35 to 95 percent on sites where infestations ranged from 0.4 to 1.2 larvae per square foot of surface-soil area. A larval infestation slightly exceeding an average of 1 specimen per square foot was sufficient to destroy most of the young corn plants. In June, 1938, adults demonstrated their destructiveness to tasseling corn by causing an estimated defoliation of 50 percent in several fields observed. From March to May of the same year many banana leaves in the Dededo district were denuded and large portions of the leafy area on coconut palms were stripped by the beetles.

FOOD PLANTS

Surveys of adult and larval infestations from 1937 to 1939 revealed hosts to be attacked as indicated below.

Cultivated Hosts	*Stage of Pest*
Avocados (*Persea* spp.)	Adults
Bananas (*Musa* spp.)	Adults
Beans (*Phaseolus* spp.)	Larvae
Breadfruit (*Artocarpus* spp.)	Adults
Cassava (*Manihot utilissima*)	Adults
Citrus (*Citrus* spp.)	Larvae
Coconut palm (*Cocos nucifera*)	Adults and larvae
Coffee (*Coffea* spp.)	Larvae
Corn (*Zea mays*)	Adults and larvae
Kapok (*Ceiba pentandra*)	Adults
Wild Hosts	
(Baryxylum) *Peltophorum inerme*	Adults
Bauhinia malabarica	Adults
Carissa arduina	Adults
Cestrum pallidum	Adults
Euphorbia didyma	Adults
Grasses (several varieties)	Larvae
Guamia marannae	Larvae
Hibiscus tiliaceus	Adults
Leucaena glauca	Adults
Malpighia glabra	Adults
Phyllanthus sp.	Larvae
Pithecellobium dulce	Adults
Sida rhombifolia	Larvae
Urena lobata	Larvae

There are probably other hosts in addition to those in the foregoing list. Roots of grasses, weeds, corn, and coconut palms are preferred hosts of the larvae, while leaves of bananas, coconut palms, tasseling corn, and Manila tamarind (*Pithecellobium dulce*) are preferred by adults.

DESCRIPTION

EGG

The freshly deposited egg is pearly white, elliptical, approximately 2 mm in length, and slightly more than 1 mm in diameter. It begins enlarging on the second day of incubation, becomes oval by the fifth day, and attains a size from 2 to 3 times the original before it hatches.

LARVA AND PUPA

Descriptions by Dr. Adam G. Böving may be found in the following paper herein.

ADULT

The original description of *Ancylonycha mindanaona* by Brenske was somewhat brief. The ensuing description was therefore prepared by Dr. E. A. Chapin:

Color above medium to pale castaneous, head and pronotum slightly darker than elytra,

underparts paler, yellowish brown, legs castaneous with extreme apices of tibiae (entire outer margin of anterior tibia) darker, apices of mandibles and maxillae nearly black.

Head coarsely and closely punctured, the punctures tending to form longitudinal groups of two or three. Clypeal suture slightly sinuate, clypeus with strongly reflexed anterior margin which is very broadly and very feebly notched at middle. Antenna 10-segmented, club in male about as long as first segment, in female about three-fourths as long as first.

Pronotum more than twice as broad as its length along median line, all margins finely beaded, apical angles subacute, basal angles obtuse, lateral margins nearly parallel in apical fourth, thence strongly diverging to basal third, the point of greatest breadth of pronotum. Surface moderately coarsely and sparsely punctured on disc, more finely and densely punctured in lateral thirds.

Scutellum broadly triangular, with a few coarse punctures.

Elytron with prominent humeral callus and moderately convex sutural bead, apical sutural angles in male minutely mucronate, in female simple. Surface as coarsely and slightly more densely punctured than disc of pronotum, with very feeble traces of three discal costae. Pygidium sparsely and coarsely punctured.

Underparts of metathorax rather finely and densely punctured, rather densely clothed with pale hair. Abdominal sternites, except terminal, completely anchylosed with sutures obliterated across middle, very sparsely punctured at middle, more dense laterally. Terminal sternites not notably different in the sexes. Tarsal claw strong, moderately curved, accessory tooth acute and subbasal.

Aedeagus, Figs. 1–3; female genital plates, Fig. 4.

Length: 17–19 mm.

Known distribution: Philippine Islands (Mindanao and Luzon); Guam.

The identification of the Guam specimens was based on comparison with material from Mindanao in the C. F. Baker Collection identified by the late J. Moser.

LIFE HISTORY AND HABITS

Studies of the life history of *Ancylonycha mindanaona* were conducted under field conditions from July, 1937, to May, 1939, and in an open-air insectary from March through May in 1938–39, when pupae, adults, and eggs were abundant. Adults collected in the field in April, 1938, were confined to cages kept in an undisturbed shed, because females would not oviposit under insectary conditions.

DEVELOPMENTAL PERIODS

The records shown in Table 1 were obtained for eggs in April, 1938, for larvae from April, 1938, to March, 1939, and for pupae, including some specimens developing from mature larvae collected in the field, from March to May, 1938–39. It may be seen from these that the insect has an annual life history.

TABLE 1.—LENGTH OF IMMATURE STAGES OF ANCYLONYCHA MINDANAONA UNDER CAGE CONDITIONS

Stage	Specimens	Length of Stage		
		Minimum	Maximum	Average
	Number	*Days*	*Days*	*Days*
Egg	205	11	15	12.1
Larva	19	290	309	301
Prepupa	45	5	20	[1]
Pupa	30	16	20	17.4
Egg to adult	19	323	346	335

[1] No complete data.

The eggs studied were deposited by the beetles in boxes of sifted moist soil placed in cages with adults early in the morning and removed at dusk when beetles emerged to feed. Eggs were incubated in small tins and in partially open petri dishes containing moist soil.

Newly hatched larvae were placed in drums containing a mixture of leafmold and soil previously planted to centipedegrass, *Eremochloa ophiuroides*. Periodical observations of the grass roots established approximate periods when larvae changed from feeding on soil organic matter to living plant material. On January 31, 1939, the larvae, having discontinued their feeding, were transferred singly into vials containing sufficient soil for the formation of pupal cells. After entering the prepupal stage each specimen was placed on a layer of cellu-

cotton covering a layer of soil, needed to supply moisture, in a vial where dates of pupation and final transformation to adult could be established. The open end of every vial was loosely plugged with cotton to retard the escape of moisture. Subsequent attempts to ascertain pre-emergence periods of adults newly transformed from pupae, by holding them separately in caged tin cans of soil under insectary conditions, resulted in failures, as no specimens emerged and all died within a few weeks.

LARVA

The length of the larval stage, ranging from 290 to 309 days (Table 1), was possibly shortened under cage conditions. The young larva, hatching in March or April, remains at a depth of 5 or 6 inches in the soil, where it feeds on decaying organic matter until it is almost full-grown in July, when the summer rainy season begins. Moisture conditions then being favorable, it rises closer to the soil surface to attack living roots of an abundant weedy and grass growth, or other hosts. If the host is cleared away before November and is replaced by a cultivated crop, the latter—corn for example—is attacked as soon as roots develop. The larva burrows more deeply into the soil from late November to January, probably to escape dry surface-soil conditions following reduction in rainfall, and forms an earthen pupal cell by January if a food supply is absent. Some larvae may continue feeding until March or later if a host is available. The cell is usually to be found near a limestone rock formation ranging in depth, at Dededo, from 5 to 13 inches. The latter depth is generally sought, judged from groups of mature larvae and pupae often found in small areas where the soil was slightly deeper than the average surrounding soil depth. The larva remains in the cell for days, or even weeks, turns slightly brown, becomes limp, shrinks to almost half its former size, and finally casts its skin to become a pupa.

PUPA

The first noticeable change in a pupa in transforming to an adult is the early replacement of the pearly-white color by a creamy color. The eyes and tibia become slightly brown on the fifth day, as do the head and thorax on the seventh day. The entire specimen is brown by the eleventh or twelfth day. The pupal skin is then cast several days later to complete the transformation.

ADULT

Feeding habits.—The adult remains in its pupal cell for several days after transformation, before emerging to feed. After maturity, it emerges from the soil at dusk, flies

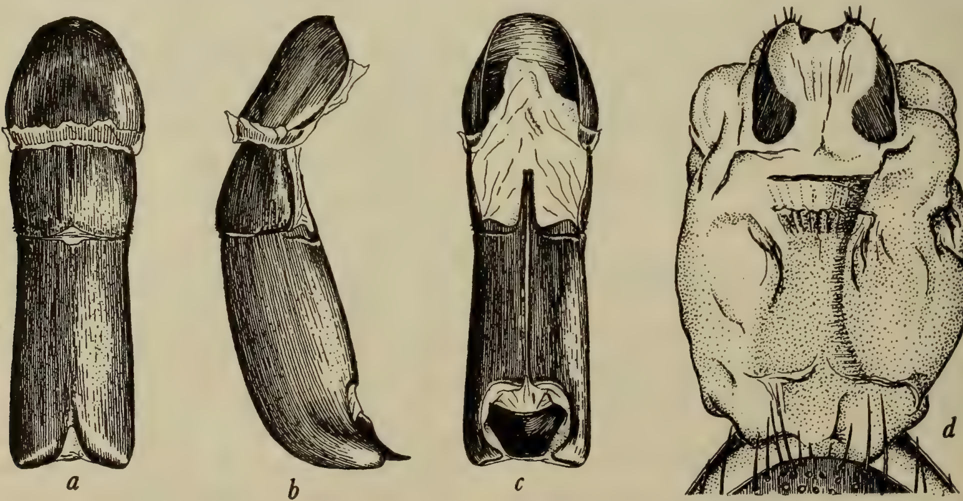


Fig. 2.—*Ancylonycha mindanaona: a–c,* male genitalia; *d,* female genitalia. Drawings by A. D. Cushman.

briefly or until a desirable host is reached, then feeds voraciously for an hour or two on the outer edge of a leaf. It mates later during the night and continues to feed until just before daybreak, when it flies to soil nearby, hiding during the day at depths of 2 to 6 inches.

The adult probably continues to feed nightly throughout its life after its emergence from the pupal cell. Although average adult longevity appears to be of only a few weeks' duration, the individual beetle consumes a large amount of leafy material.

Oviposition habits.—When a female discontinues feeding at daybreak, it flies to the ground, burrows to a depth of from 4 to 6 inches, and spends the day either resting or ovipositing. Eggs are laid singly, or in groups of 2 to 5. A glutinous substance secreted on each egg causes soil to adhere to it as a protective covering. The total number of eggs an adult may deposit was not established, although dissections of numerous females indicated an average of about 30.

Small valleys or depressions where moisture prevailed during the dry season appeared to be more favorable to larval survival but were apparently given little preference by females for oviposition sites. It even seemed doubtful that the type of plant cover had much influence on the selection of places for oviposition. That there was some selection of loose soils is supported by the fact that larvae were found mostly in sandy portions of lowland soils at Piti in 1938–39. Adults probably had difficulty in penetrating the clay loam soils, particularly in uncultivated areas, which were dry and well baked during the season of oviposition. Concentrations of larvae in Dededo fields during the fall of 1937–38 were invariably found near host plants of the adults. In one cornfield, for example, 100 percent of the plants were destroyed by larvae in an area located within 75 feet from the forest edge, but at a greater distance only an occasional plant was molested.

SEASONAL OCCURRENCE

There is a slight overlapping of the one generation per year of *Ancylonycha mindanaona* in Guam (Table 2).

TABLE 2.—SEASONAL OCCURRENCE OF THE VARIOUS STAGES OF ANCYCLONYCHA MINDANAONA AT DEDEDO, GUAM, IN 1938–39

Stage	Period of occurrence[1]	Period of greatest prevalence
Adults....	Feb. 20 to Aug. 15	March 15 to April 30
Eggs......	Feb. 25 to June 1	March and April
Larvae....	March 10 to May 25 of succeeding year	June and July
Pupae.....	Feb. 1 to May 30	March

[1] Exact dates given represent the earliest and latest dates on which individuals were actually observed in the field.

At Dededo in 1938 the beetle flight began late in February and at Piti early in March. During the same year the maximum flight occurred about April 20 at the latter place, according to data obtained from small catches of beetles in light traps. The data also showed a rapid decline in the population later and a complete disappearance of beetles by August 6. Oviposition begins almost immediately after the first beetle emergence, but apparently ceases long before the last beetles of a season disappear.

Larvae of a single generation occur over a period covering almost 15 months (Table 2). The peak population is reached in June or July, or within 3 to 4 months after the first appearance of larvae in March, then starts to decline. It develops during a period of dry weather, which may cause considerable mortality of both eggs and young larvae. The 1938 generation appeared small in size in July, by comparison with the number of beetles present to oviposit in the previous March and April, and was less than one-fifth of its maximum level by January, 1939, according to results of surveys conducted in 10 fields. Maximum concentrations of approximately 8 larvae per square foot of surface soil existed in July at one site, as compared with 1 larva per 10 square feet in November.

CLIMATIC AND SOIL CONDITIONS IN GUAM POSSIBLY AFFECTING LIFE HISTORY

Soils on the Island of Guam are largely of three general types—the shallow upland limestone type, lowland clay loams, and savannah lands. The upland soils are porous and shallow with an underlying limestone-rock formation, of which outcroppings are frequently to be seen; are usually from 6 to

8 inches in depth but may be a few inches deeper at some sites; and have little water-holding capacity. The lowland and savannah-land soils are several feet in depth; the former having small sandy areas in spots. The savannah soils cover the greater portion of the southern half of the Island and produce a thick growth of swordgrass. Infestations of *Ancylonycha mindanaona* were most severe in the loose upland soils prevalent at Dededo and near Asan, and in the limited sandy areas in the lowland at Piti. No infestations were observed in the savannah lands.

The average total annual rainfall in Guam for the period July 1, 1937, to June 30, 1939, was 79.77 inches, a reduction from a normal average of approximately 95 inches. Most of it occurred during a distinct rainy season extending from June to November and was followed by a dry season from January to May during which time the average monthly rainfall amounted to less than 5 inches. The temperature and relative humidity were less variable, the former ranging from 71° to 92°F. and the latter averaging 80.8 percent. Daily mean minimum and mean maximum temperatures approximated 74° and 87°, respectively.

Crops growing in lowland areas during the period from December to June suffer from lack of rainfall; nevertheless they often yield fair-sized harvests. Those in upland areas, however, must as a general rule reach maturity by December, in order to escape drastic effects of too little rainfall from that month to the following May. Young crops are likely to be drowned out in either area by excessive rainfall, sometimes exceeding 25 inches, in August. Favorable months for planting corn in the upland areas are therefore limited to May, June, September, and October. The problems of successful grain storage, inadequate land acreage for cultivation, and an even distribution of labor make plantings in the two last-named months very desirable, yet they fit favorably into the habits of the larvae of *Ancylonycha mindanaona*.

SUMMARY

The scarabaeid beetle *Ancylonycha mindanaona* (Brenske) was a destructive pest in both the larval and adult stages in Guam in 1937–38. The 1939 generation was smaller than the previous ones. The larvae feed on roots of plants and the adults attack foliage at night.

Life-history studies proved that the pest completed its cycle in one year, with an egg stage of from 11 to 15 days, an approximate 10-month larval stage, and a pupal stage of 16 to 18 days. Eggs occur largely from March to May, larvae from March of one year to March of the following year, pupae from February to May, and adults from February to August with the peak in April.

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ENTOMOLOGY.—*Description of the larva and pupa of the scarab beetle* Ancylonycha mindanaona (*Brenske*).[1] ADAM G. BÖVING, U. S. Bureau of Entomology and Plant Quarantine.

In the larval stage *Ancylonycha* appears congeneric with the genus *Phyllophaga* from the mainland of America and is inseparable from it except on geographical grounds. To be sure, the larva of *Ancylonycha mindanaona* is readily separated from all the species of *Phyllophaga* by possessing numerous round, dark spots (*DS*, Figs. 3, 7) on different places of the body, but similar dark spots have not been found on the larva of any other known species of *Ancylonycha* and must therefore be considered as a specific, not a generic, character. The larva of *A. mindanaona* comes very close to the larvae of the least-differentiated species of *Phyllophaga*, notably to the larvae of *P. vetula* (Horn), *P. crinita* (Burmeister), and *P. tristis* (Fabricius).

In the following description of the three larval instars of *A. mindanaona*, little regard is paid to the tribal and generic characters, which, as mentioned, are identical with those well known in the corresponding instars of *Phyllophaga*. On the other hand, all the specific characters are given that show the systematic relation of *Ancylonycha mindanaona* to the different species of *Phyllophaga* and especially the three abovenamed forms.

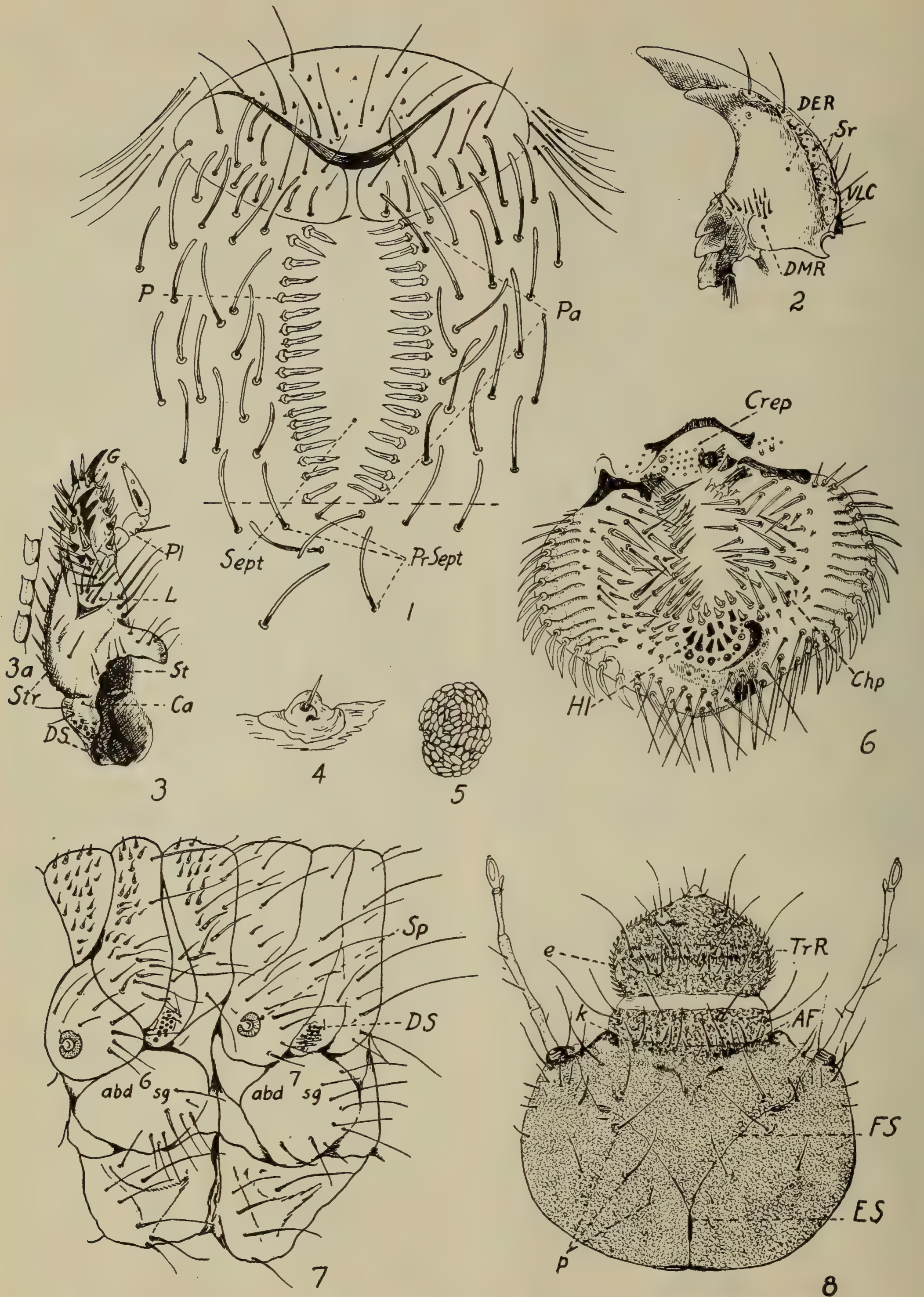
DESCRIPTION

First-stage larva.—(Typical sample in U. S. National Museum labeled: "Interception No. 556, reared from eggs oviposited by adults in Interception No. 554; Guam 1938. R. G. Oakley.") Posterior part of labrum behind the transverse labral ridge without setae (compare *TrR*, Fig. 8). Anterior marginal region of frons (*AF*, Fig. 8) with one moderately long seta on each side. Epicranium on each side opposite the concave posterior part of the frontal suture (*FS*, Fig. 8) and the epicranial suture (*ES*, Fig. 8) with two setae. Dorsomolar region of right mandible (compare *DMR*, Fig. 2) with a transverse patch of about 12 setae; dorsoexterior region (*DER*, Fig. 2) with no punctures and no setae; scrobis (*Sr*, Fig. 2) with about 10 punctures in a longitudinal row and no setae; ventrolateral carina (*VLC*) without setae; basolateral region with a patch of about seven fairly long and small setae. Epipharynx (compare Fig. 6) with about nine heli (*Hl*); proplegmatium absent; chaetopariae (*Chp*) without punctures among the setae; crepidal punctures (*Crep*) about 20. Raster (compare Fig. 1) with an elongate-ovate septula (*Sept*), which is sometimes slightly constricted at the middle; palidium (*Pa*) with one regular row of about 25 slightly curved, pointed, rather short pali (*P*); distance between bases of pali from less than half the length of a palus to as long as, or longer than, a palus; preseptular setae (*PrSept*) five or a few more. Numerous dark spots present in groups on different parts of the body but especially in the bottom of a fold posterior to the spiracles of most segments (compare *DS*, Fig. 7). Hatching tooth (=ruptor ovi) (Fig. 4) on the posterior dorsal area of metathorax, small, dome shaped, and with a moderately long seta. Spiracles (Fig. 5) with a circular, disk-shaped, multifenestrate, cribriform respiratory plate and no bulla and no spiracular orifice. Mediodorsal length of body, measured segment by segment from anterior margin of prothorax to V-shaped anus, about 9 mm; width of head capsule about 2.5 mm; length of head capsule about 2 mm.

Second-stage larva.—Similar in all characters to the third-stage larva, except in size. Mediodorsal length of body from anterior margin of prothorax to anus about 28.5 mm; width of head capsule about 5 mm; length of head capsule about 3 mm.

Third-stage larva.—(Typical sample in U. S. National Museum labeled: "In soil, field; Guam; Guam No. 1784; 17.III.1939; R. G. Oakley.") Labrum (Fig. 8) rugose, with posterior part behind the labral ridge (*TrR*) bearing a transverse, irregular series of about six moderately long setae (*e*) on each side. Head capsule finely verrucose, yellowish brown. Anterior marginal region of frons (*AF*) with a transverse, irregular series of six to nine moderately long setae (*k*) on each side (and sometimes with a few short additional setae). Epicranium (Fig. 8) on each side opposite the concave posterior part of one of the frontal

[1] Received October 4, 1944.



FIGS. 1–8 —(*See opposite page for legend*)

sutures (*FS*) and the epicranial suture (*ES*) with a somewhat oblique, longitudinal series of three setae (*p*) of various lengths. Dorsomolar region (*DMR*, Fig. 2) of right mandible with a transverse patch of about 12 setae, dorsoexterior region (*DER*) with no punctures and no setae; scrobis (*Sr*) without setae but with several longitudinally arranged sensorial punctures distributed over most of the surface and in the wall of the carinae, which limit the region; ventrolateral carina (*VLC*) with about 10 moderately long setae; basolateral region with a patch of about 10 fairly long setae. Epipharynx (Fig. 6) with about nine heli (*Hl*); proplegmatium absent; chaetopariae (*Chp*) without sensorial punctures among the setae; crepidal punctures (*Crep*) about 20. Raster (Fig. 1) with elongate-ovate septula (*Sept*); palidium (*Pa*) with one regular row of from 20 to 27 depressed, straight, dagger-shaped, pointed and (when not worn) moderately long pali (*P*); distance between bases of pali about half as long as, or considerably shorter than, length of a palus; preseptular setae (*PrSept*) six or a few more or less. Claws unequal in length and different in shape on the three pairs of legs; on first and second pairs of legs about one-third length of tibiotarsi, enlarged at bases, straight and distally pointed; on third pair of legs less than half as long as claws of first and second pairs of legs, at base enlarged and distinct but distally very short. Spiracles (*Sp*, Fig. 7) well developed, each with the respiratory plate C-shaped, surrounding more than three-fourths circumference of bulla, and with an open, curved, spiracular orifice; minute fenestral elements of cribriform respiratory plate oval and arranged in numerous transverse series with about 20 in each series; thoracic spiracle one and one-half times as large as the first abdominal spiracle; abdominal spiracles decreasing slightly and gradually in size posteriorly. Mediodorsal length of body, measured segment by segment from anterior margin of prothorax to the simple V-shaped anus, 42.5 mm; width of head 6 to 6.2 mm; length of head 4 mm.

Pupa.—Body soft-skinned, free from vestitures, all segments without lateral expansions. Mesonotum and metanotum slightly grooved longitudinally in the middle line; scutellum distinct. Base of each elytron with a thornlike, conical projection. Dorsal portion of each of the anterior abdominal segments rounded, but dorsal portions of the last three segments more flattened and with obtusely waved wrinkles; posterior margin of dorsum of each of fourth and fifth abdominal segments furnished with a pair of paramedian, dark, flat, dorsally convex knobs. Pleura of abdominal segments fused with their ventral parts. Cerci rather slender, conical, glabrous, directed obliquely backward and extenuated into a corneous, incurved, sharply pointed hook; each cercus about five times as short as one of the sides of the ninth abdominal segment. Anterior four pairs of abdominal spiracles provided each with a slightly tubular, rather thick and dark peritrema; rest of abdominal spiracles without distinct and dark peritremata. Mediodorsal length of pupa, measured from middle of vertex to posterior end of abdomen (excluding the cerci), about 28 mm; greatest width of prothoracic shield about 8 mm.

FIGS. 1–8.—LARVA OF ANCYLONYCHA MINDANAONA (BRENSKE)

The drawings for the figures were made by the author. When a figure presents a dorsal view of a structure the front part of the structure is shown pointing toward the upper margin of the plate, but when a figure gives a ventral view it is the rear part which points toward the upper margin. The right and left sides of the structure as they appear on the figure will then correspond to the veritable right and left sides of the structure in natural position on the insect when the latter is seen from above with its head away from the observer.

FIG. 1.—Raster: *P*, palus; *Pa*, palidium; *PrSept*, preseptular setae; *Sept*, septula. FIG. 2.—Right mandible, dorsal view: *DER*, dorsoexterior region; *DMR*, dorsomolar region; *Sr*, scrobis; *VLC*, ventrolateral carina. FIG. 3.—Left maxilla (facing the cavity of the mouth): *Ca*, cardo; *DS*, dark spots; *G*, galea; *L*, lacinia; *Pl*, palpus; *St*, stipes; *Str*, stridulatory teeth. FIG. 3a.—Stridulatory teeth. FIG. 4.—Hatching tooth (ruptor ovi). FIG. 5.—Spiracle of first-stage larva. FIG. 6.—Epipharynx, ventral view: *Chp*, chaetoparia; *Crep*, crepidal punctures; *Hl*, helus. FIG. 7.—Sixth and seventh abdominal segments, lateral view: *DS*, dark spots; *Sp*, spiracle. FIG. 8.—Dorsal surface of head: *AF*, anterior marginal region of frons (with 6 to 9 setae, *k*, on each side); *ES*, epicranial suture; *FS*, frontal suture (*p*, oblique longitudinal series of 3 setae opposite and close to the concave posterior part of frontal suture and the epicranial suture); *TrR*, posterior transverse labral ridge (*e*, transverse series of about 6 setae on each side behind the ridge).

ENTOMOLOGY.—*Five mites of the family Ereynetidae from Mexico.*[1] EDWARD W. BAKER, Bureau of Entomology and Plant Quarantine. (Communicated by ALAN STONE.)

The mites of the family Ereynetidae are prostigmatic and in addition are characterized by the two pairs of long, finely pilose, sensory hairs, one pair on the thorax and the other on the rear of the abdomen; by the 3- or 5-segmented palpus; and by the presence of two pairs of genital cups. Most of the species are known from Europe, the majority of these being parasites or "pseudoparasites" on snails and insects, although some are found in moss or on plants. Of the five species presented in this paper, one is already known from snails in Holland, while the others appear to be new. Type slides, as well as a slide of the snail-inhabiting species, have been deposited in the United States National Museum, Washington, D. C.

Genus **Riccardoella** Berlese

Riccardoella oudemansi Sig Thor

Fig. 1

Riccardoella oudemansi Sig Thor, Zool. Anz. **99**: 249, figs. 1–17, 1932; Das Tierreich **60**: 63, figs. 71–87, 1933.

(Description after Sig Thor, 1933. Translated by the author.) Body broad, egg-shaped, rounded, not segmented. Color yellowish or reddish white, with a broad dorsal stripe. Skin with fine tuberculated striations. Hairs short, stiff, thick, and finely pilose. Rostrum short, broad, sharpened triangularly to tip, with two pairs of very short, pilose hairs. The 3-segmented, short palpus has short, relatively thick segments, the end segment with four short, pilose hairs. Thorax without eyes or chitinous plates but with the usual four pairs of hairs; between the two long sensory hairs the usual setae, and close anteriorly a pair of very small hairs; thoracic shoulder hairs longer, the 14 abdominal hairs of the usual arrangement and size. Few hairs ventrally; five pairs of small genital hairs, and five pairs of longer hairs more laterally. Two pairs of round genital cups. Anal opening indistinct (easily seen in Mexican material). Epimera of medium size, with one to three pairs of hairs; the two anterior pairs of epimera have a single bent chitinous rod or plate. The legs relatively thick and short, about 200–240μ long, with few pilose hairs. On the tarsi many flat, leaflike, pilose hairs; a small clavate seta on tarsi I and II; two weak claws and a pilose tarsal pad. Length about 360–400μ, width 224–280μ.

In Holland the mite was taken on *Limax* sp. In Mexico, D. F., the mites were found in some abundance running over the slimy part (the foot) of the snail *Helix pomatia* Linnaeus, which is European in origin. The mites were taken December 4, 1943.

Genus **Opsereynetes** Sig Thor

Opsereynetes simplexus, n. sp.

Fig. 2

Female.—Of medium size; thoracic furrow entire in fresh mounts; amber colored, with a lighter dorsal stripe and lighter legs and beak. Striations typical. Rostrum of normal size; venter with a pair of pilose hairs out under segment I of palpus, and a posterior pair of pilose hairs. Second mandibular segment long, narrow, slightly curved. Palpus of normal length, segment III reaching to about tip of rostrum, 22μ long and 16μ wide, with two pilose hairs about as long as segment IV; segment IV 11μ long and 9μ wide, rounded, with two pilose hairs about length of segment; segment V 10μ long and 5.5μ wide, constricted toward tip, with two pilose lateral hairs and a simple strong end hair. Cephalothorax with a pair of large eyes just outside and slightly anterior to the thoracic sensory hairs; all body hairs pilose; thoracic sensory hairs 83μ long; the tiny pair of hairs just anterior to the sensory setae 5.5μ long; longer pair 16.6μ long, between the sensory setae. No chitinous shields seen. Dorsal abdominal hairs 19.5μ long; posterior abdominal sensory setae 75μ long. Anal opening on rear. Genital opening of female with five pairs of pilose hairs. Legs normal; legs I, III, and IV about 166μ long, leg II 133μ long; all leg hairs pilose, those on tarsi strong; tarsus I with a small, broad, clavate seta; tarsus II with a narrow clavate seta. Tarsal pads with hairs. Length with rostrum 266μ, width about 100μ.

[1] Received September 18, 1944.

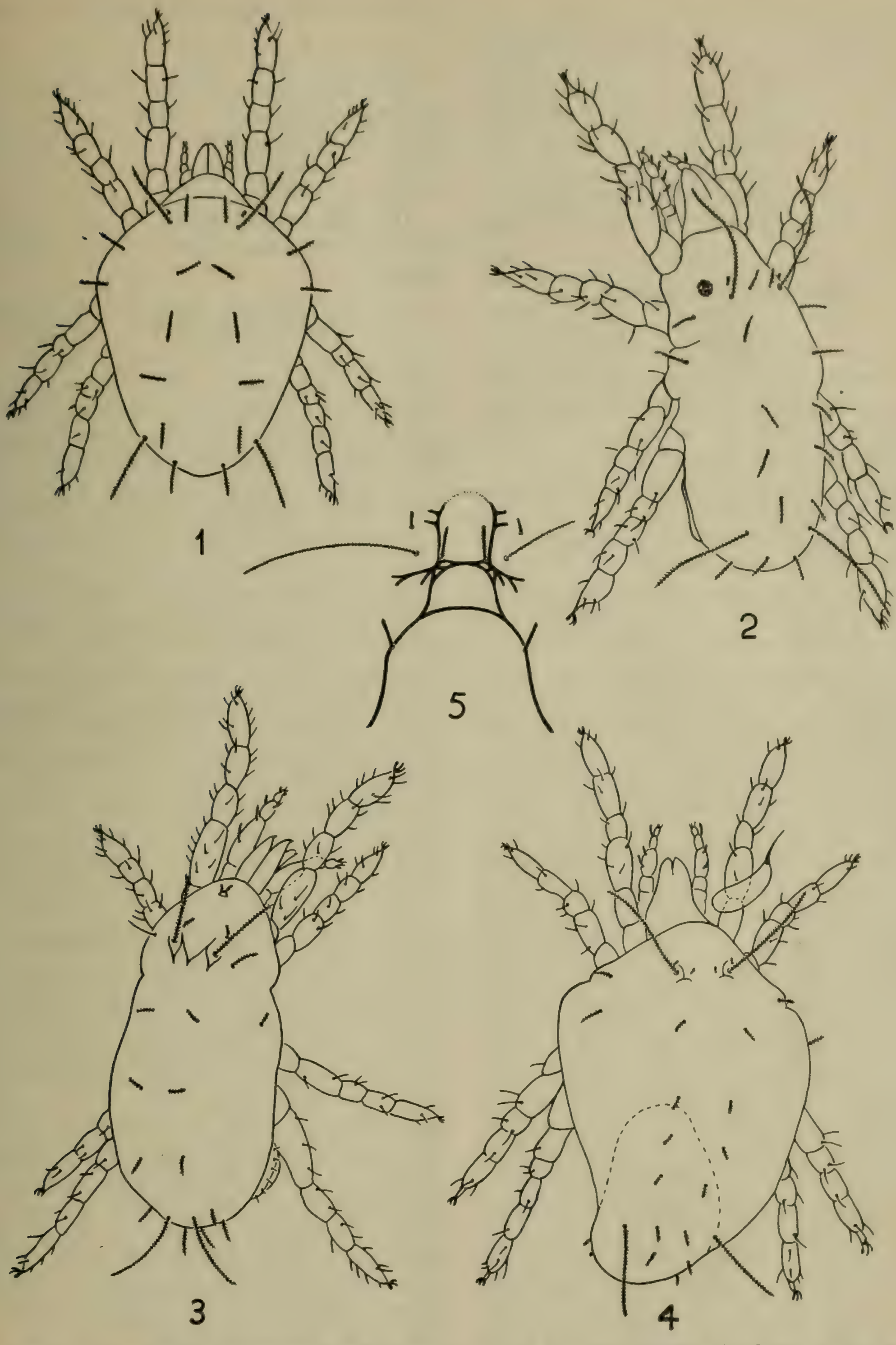


FIG. 1.—*Riccardoella oudemansi* Sig Thor, adult. FIG. 2.—*Opsereynetes simplexus*, n. sp., adult. FIG. 3.—*Opsereynetes tuberculatus*, n. sp., adult. FIG. 4.—*Opsereynetes robustus*, n. sp., adult. FIG. 5. —*Ereynetes sabinensis*, n. sp., camera-lucida drawing of dorsal shield.

Type.—U.S.N.M. 1468.

Type on slide with two paratypes from moss taken at the Desierto de los Leones, Mexico, December 5, 1943. A nymph was also collected from moss by Penelope, Carlos, and Sandra Plummer, November 19, 1943, at the same locality.

The lack of dorsal shields and presence of strong pilose hairs are distinctive of this species.

Opsereynetes tuberculatus, n. sp.

Fig. 3

Female.—Of medium size; body furrow not seen dorsally but present laterally; light amber-colored body with lighter legs and beak. Finely striated. Rostrum of normal size, pointed; venter with a pair of fine pilose hairs out under segment I of palpus and a pair of anterior pilose hairs. Mandibular segment I not broad, sides about parallel; second mandibular segment short, stubby, slightly curved. Palpus shorter than that of the other species, segment III reaching about to tip of rostrum; segment III with one center and one distal hair, both pilose, the distal hair reaching about halfway out of segment IV; fourth segment oval, with three pilose hairs not so long as segment is wide; fifth segment about as long as fourth is wide, constricted toward tip, but rounded, with four or five end hairs, which appear pilose. Cephalothorax not distinct from abdomen dorsally; eyes not seen (probably dissolved by mounting fluid); sensory setae about 50μ long, fine, wire-like, pilose; laterad of sensory setae a pair of pilose hairs about 20μ long; anteriorly and slightly inside a pair of shorter pilose hairs, about 15μ long; in the center and anteriorly a small tubercle with two short pilose hairs about 10μ long. Shield lines all faint, hard to see (in some specimens not seen), consisting of a branch forking to include the sensory hair and apparently connected medianly by another forking line as illustrated. Abdominal body hairs about 12.5μ long, stiff, strong, pilose; posterior sensory hairs fine, pilose, of same length as thoracic sensory hairs. Ventral body hairs short, pilose, broadening slightly toward tip. Six pairs of pilose genital hairs; three pairs more laterad. Legs apparently normal, sparsely haired with blunt, heavy, short, pilose setae; length of legs: I, 166μ; II and III, each 133μ; IV, 155μ; tarsus not blunt at tip; tarsal pads with hairs. Length with rostrum 255μ, width 111μ.

Type.—U.S.N.M. 1469.

Type and paratype from moss from the Desierto de los Leones, Mexico, February 7, 1943. Also a paratype from the west slope of Mount Popocatepetl at about 9,000 feet, December 29, 1943.

The faint dorsal shield and lines and the anterior tubercle appear to be distinctive for this species.

Opsereynetes robustus, n. sp.

Fig. 4

Female.—Of medium size; light amber in color; active. Body furrow not seen dorsally, present laterally; body broad in shoulders. Finely striated. Rostrum of normal size blunt at tip; venter with a single pair of posterior pilose hairs. Mandibles not sharp, somewhat blunt but broader at base; second mandibular segment long (about two-thirds as long as first segment), curved, somewhat thicker at base. Palpus of moderate length, segment III reaching past tip of rostrum; third segment with two pilose hairs, one in center and one on apex; fourth segment with one pilose hair the length of the segment; fifth segment small, round, with four or five end hairs, which appear to be simple. Cephalothorax short, not defined dorsally from abdomen; eyes not seen (probably dissolved by mounting fluid); anterior sensory setae fine, pilose, 66–77μ long; inside anterior sensory setae a pair of short pilose hairs, and anterior and outside another pair of short pilose hairs; the thoracic shoulder hairs longer, of the size of the abdominal hairs. Thoracic shield lines hard to see, fine, short, in form of a half circle medianly of the sensory hairs and connected posteriorly to another fine, short line; not connected to one another. Dorsal abdominal hairs heavy, pilose, about 14μ long; abdominal sensory hairs about 56μ long, pilose. Five pairs of short pilose genital hairs; large egg in body, about 70μ times 110μ; anal opening on rear. Legs of normal size: legs I and IV about 157μ long, II and III each, about 135μ long. Legs sparsely clothed with short, blunt, pilose hairs; tarsal tips stubby, with a pilose tarsal pad and normal claws. Length with rostrum about 292μ, width about 157μ.

Type.—U.S.N.M. No. 1470.

The type was found in moss collected by

Penelope, Carlos, and Sandra Plummer at the Desierto de los Leones, Mexico, November 19, 1943. The allotype (male) is on the type slide for *Ereynetes tuberculatus*, n. sp.

The body shape and the dorsal lines are distinctive.

Genus **Ereynetes** Berlese

Ereynetes sabinensis, n. sp.

Fig. 5

Female.—Medium sized; color not known, as described from mounted specimen. Finely striated. Rostrum somewhat long and narrow in proportion to body; venter with a pair of medium-length posterior pilose hairs and a pair of shorter anterior pilose hairs. Second mandibular segment of medium length, curved. Palpus slender; segment III slender, with two medium-length pilose hairs; segment IV with one medium-length pilose hair, segment V hard to see but with several apparently simple hairs. Cephalothorax with dorsal chitinous pattern as shown by the camera-lucida drawing in Fig. 5, anterior portion either weakly or not at all connected. Thoracic sensory setae fine, pilose, about 78μ long; shoulder hair 25.5μ long; thoracic setae on shield pattern about 12.7μ long, the hairs anterior to these about half that length; all pilose and strong. Abdominal hairs about 16.6μ long, strong, pilose; posterior abdominal hairs shorter. Seven pairs of short, strong, pilose genital hairs. Legs normal; leg hairs strong, pilose. Length with rostrum 288μ, width 122μ.

Type.—U.S.N.M. No. 1471.

A single female was collected by Dr. F. Bonet in bat guano in the Cueva de los Sabinos, San Luis Potosí, April 3, 1942.

The thoracic shield pattern appears to be distinctive.

ZOOLOGY.—*A new starfish of the genus* Luidia *from the coast of Georgia.*[1] AUSTIN H. CLARK, U. S. National Museum.

The genus *Luidia*, represented in all seas except the polar and subpolar, includes 45 species, of which nine occur in the western Atlantic, chiefly in the Tropics, two of these ranging to west Africa. The discovery of a well-marked new species of this genus in a region so well known as the southeastern United States is a matter of no little interest.

Luidia bernasconiae, n. sp.

Diagnosis.—A species of the *alternata* group (subgenus *Alternaster*) with 5 arms, numerous long and prominent paxillar spines, the actinal intermediate plates with pedicellariae, and the lateral paxillae each with a prominent pedicellaria.

Description.—R = 100 mm; r = 10 mm; breadth of ray at base 12 mm. The arms are slender, tapering evenly to a rather sharply rounded tip, rather thick, the abactinal surface flat and the sides, formed of the three outermost rows of paxillae, sloping abruptly down to the inferomarginals, as in *L. alternata*.

Above the inferomarginals there are three regular longitudinal rows of paxillae arising from quadrilobate plates; these paxillae form regular transverse as well as longitudinal rows, each transverse row corresponding to an inferomarginal. The paxillae of the two outermost rows are similar, rather small, each isolated from its neighbors. The crown is more or less convex and bears about 15 rather stout cylindrical spinules with rounded tips, the length of which is slightly greater than the diameter of the crown. In addition to the spinules each paxilla bears on the distal side a conspicuous stout pedicellaria slightly longer than the spinelets with two or three, very rarely four, valves. The paxillae of the third row alternate large and small. The small paxillae resemble those of the two outer rows, and each bears a conspicuous stout pedicellaria. The large paxillae, the diameter of which is two or even three times that of the small, bear a stout pointed central spine 3 mm in length the base of which is surrounded by 25 or 30 spines resembling those of the other paxillae, arranged in a complete outer and more or less incomplete inner row.

On the aboral surface between these three lateral rows on either side the paxillae are irregular in arrangement, smaller and lower, and arise from polygonal, often 5-sided, bases.

[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received October 4, 1944.

In the middle third of the arm they are composed of one to four much swollen club-shaped spinules, which are surrounded by seven to nine spinules of the usual type. The paxillae on the outer borders of this median band, which are larger and intergrade with the lateral paxillae, carry pedicellariae, and some of them bear long central spines. Spines therefore occur in a continuous row along the dorsolateral border of the arms, with a partial row borne on the adjacent paxillae and a few on the next, very irregular, paxillar row. The paxillae of the middle third of the arms do not bear spines or pedicellariae.

The paxillae of the central portion of the disk are small, like those of the midline of the arms, but intermixed with these are a dozen or so larger ones bearing spines of various sizes.

In a general view of the aboral surface the paxillae do not form a continuous and unbroken covering studded with numerous granules (the broadly rounded tips of the spinules) as in *L. alternata* and in *L. numidica;* the paxillae are more or less distinctly separated from each other so that each appears individually, the papular pores between them being, except in the center of the disk, everywhere more or less clearly visible.

The inferomarginal plates are narrow, and the fasciolar channels between them are deep and about as broad as the high intervening ridges. Each plate bears a stout regularly tapering spine about 4 mm long near its outer end, with frequently a similar though usually somewhat smaller spine below it. Occasionally the outer spine is smaller than the inner. The center of the ridge is occupied by four to six stout sharp spinules, the longest 1.5 to 2 mm in length, which are somewhat irregularly arranged and are flanked by similar but shorter and slenderer spinules. These spinules are all well separated from one another.

Each adambulacral plate bears a long, curved, and flattened furrow spine about 1.5 mm long. This is followed by a straight or slightly curved spine nearly 3 mm long, and this is turn by a similar but shorter and slenderer spine that has a much smaller spine situated at its base on the adoral side. The first two adambulacral plates on each side of the mouth plates each bear a very large 3-bladed pedicellaria (rarely two); these pedicellariae are larger than those on the adjacent actinal intermediate plates. None of the other adambulacral plates carry pedicellariae.

Throughout most of the length of the arms the actinal intermediate plates project in the form of a thick column resembling the stalk of a paxilla between the outer ends of the adambulacrals and the inner ends of the inferomarginals. This column is surmounted by a large conical pedicellaria 2.5 to 3 times as long as broad at the base and about 1.25 mm high with three slender jaws. Just beneath this pedicellaria on the adoral side is a very slender spinule the length of which is one-fourth to about one-half that of the pedicellaria, and there are usually from one to several similar spinules elsewhere about the summit of the column. These large pedicellariae continue to within about 15 mm of the tips of the arms, where they disappear and the plates become inconspicuous.

In the interbrachial areas about the mouth there are four actinal intermediate plates in addition to those of the complete row, each of which bears a large 3-valved pedicellaria and beneath it a circlet of about five long slender spinules.

The narrow mouth plates each bear a marginal row of four long and stout spines, which resemble those on the adjacent adambulacrals but are slightly smaller; the two innermost spines are usually slightly larger than the others. In addition to these large spines there are numerous spinules, but no pedicellariae.

The color, dried from alcohol, is uniform white tinged with pale brownish gray.

Type.—U.S.N.M. E.6718; from between 60 and 100 miles off the Sea Islands, Ga.; collected by William W. Alexander, August 6, 1931.

It gives me great pleasure to dedicate this new species to Miss Irene Bernasconi, the talented custodian of echinoderms in the Museo Argentino de Ciencias Naturales, Buenos Aires.

Comparisons.—This new species is a member of the *alternata* group of *Luidia*, the 19 members of which are distributed throughout the warmer portion of the oceans, occurring from the shore line down to 380 meters, though most of them live in shallow water. Six species of this group were heretofore known from the Atlantic, one, *numidica,* from west Africa, the other five, *alternata*, *barbadensis*, *convexiuscula*, *quequenensis*, and *variegata*, from tropical and

subtropical America, chiefly from the Caribbean region. Two of these species, *barbadensis* and *convexiuscula*, have six arms and need not be further considered. From *alternata* this species differs in the smaller paxillae with stouter spinules and in the occurrence of pedicellariae on the paxillae of the lateral portions of the arms. From *variegata* and *quequenensis* it differs in the presence of pedicellariae on the lateral paxillae, and in the fewer and more localized spine-bearing paxillae. In the presence of numerous pedicellariae on the lateral paxillae, in the character of the paxillae, and in the form of the pedicellariae on the actinal surface it agrees with the west African *numidica*. It appears to differ from *numidica* in having the spines on the abactinal surface more numerous, longer, and more slender, the abactinal pedicellariae more regular and more numerous, and the paxillae in the midline of the arms smaller with less diversified spinelets. It is without doubt the American representative of *numidica*.

ZOOLOGY.—*Notes on some recently collected hydroids in the United States National Museum, with descriptions of three new species.*[1]

C. McLEAN FRASER, University of British Columbia. (Communicated by WALDO L. SCHMITT.)

A small assemblage of hydroids from the United States National Museum, recently collected, is made up of three lots: a collection made off the coast of South Carolina, Georgia, and northern Florida by the *Pelican*, February, 1938, to February, 1940; a collection made from the lower Potomac oyster bars in December, 1942, and January, 1943; and a collection from the Louisiana State University, obtained off the Florida and Louisiana coast in the summers of 1942 and 1943, respectively.

Although only 13 species were obtained, most of them common, the collections were not lacking in interest. Three of the species appear to be new, and the known range of each of three others was extended. Two of the new species were from the *Pelican* collection and the other one from the Louisiana collection. Of the species of which the range was extended, two were from the *Pelican* collection and one from the lower Potomac.

I wish to express my indebtedness to the United States National Museum for again making available to me for study interesting hydroid material, and also to Miss Marian McCrea, of Vancouver, who has made the enlarged drawings used in illustration.

SPECIES FROM THE *Pelican* COLLECTION

Halecium gracile Verrill. Station 182–16; lat. 32°53′ N., long. 79°30′ W., 5 fathoms.

Synthecium tubithecum (Allman). Station 181–13, lat. 32°03′ N., long. 79°49′30″ W., 14 fathoms.

Monostaechas quadridens (McCrady). Blackfish Bank, S. C., depth not given.

Aglaophenia acacia Allman. Station 181–14, lat. 32°03′30″ N., long. 79°45′30″ W., 16 fathoms; station 183–11, lat. 33°40′ N., long. 78°13′30″ W., 9 fathoms. The only previous records in the western Atlantic for this species are for off North Carolina. These records extend the range southward to Savannah, Ga.

Aglaophenia aperta Nutting. Station 13, lat. 29°20′ N., long. 88°16′ W., 33 fathoms; station 14, lat. 29°20′ N., long. 88°28′ W., 30½ fathoms. There are two previous records of this species, both off Habana, the one in 194 fathoms, the other in 200. These records extend the known range some distance to the northward and into much shallower water.

Aglaophenia longiramosa, n. sp. Station 142–5. lat. 29°58′ N., long. 88°03′ W., 16 fathoms.

Cladocarpus longipinna, n. sp. Station 13, lat. 29°20′ N., long. 88°16′ W., 33 fathoms.

SPECIES FROM LOWER POTOMAC OYSTER BARS

Bimeria tunicata Fraser. Station 19, Lower Cedar Point Bar. This record extends the known range of this species very considerably, as all previously recorded specimens were obtained off the coast of Louisiana.

Clytia longicyatha (Allman). Station 1, Sheepshead Bar; 3, Cords Flats Bar; 13, Higgins Point Bar; 15 and 16, Sheepshead Bar; 18, Heron Island Bar. This must be the common species in this area, since it appeared in all the stations but one from which hydroids were collected.

[1] Received October 18, 1944.

Thuiaria argentea (Linnaeus). Station 13, Higgins Point Bar.

SPECIES FROM LOUISIANA STATE UNIVERSITY
(Presumably all littoral)

Bougainvillia inaequalis Fraser. Front Beach, Grand Isle, La.

Eudendrium speciosum, n. sp. Santa Rosa Sound, Pensacola, Fla.

Aglaophenia late-carinata Allman. Grand Isle, La.

Eudendrium speciosum, n. sp.
Fig. 1

Trophosome.—Colony erect, 4–5 cm, with a continuous main stem, nearly straight, with several branches varying very much in length; the larger ones are branched again; there is a tendency to alternation, but it is rather irregular. The main stem is practically free of annulation, although somewhere in its length there may be a single series of two or three annulations; none appears above the origin of the branches. Each branch has rather an abrupt bend near the base, and the base appears to be set on the stem rather than to be growing from it. Each branch and pedicel has four or five annulations at the base, but otherwise the surface is smooth; even in the larger branches annulations appear only at the base. The hydranth is handsome, with about 25 long, slender tentacles.

Gonosome.—Male gonophores, bithalamic, are arranged in a single whorl around the base of the hydranth which is not at all aborted. Female gonophores were not observed.

Type.—U.S.N.M. 43464.

Aglaophenia longiramosa, n. sp.
Fig. 2

Trophosome.—Colony stout, 15 cm, consists of a main stem and several long branches that grow outward at an acute angle with the stem and pass along in much the same direction as the stem, to look like a portion of the stem itself; both stem and branches are fascicled. The hydrocladia are given off alternately from both stem and branches; they are long, up to 2 cm or even more; they are divided into short internodes, but at times the nodes are not so pronounced as the internal septa, of which there are two to each internode; the one nearly opposite the intrathecal septum is strongly marked; the other, just below the supracalycine nematophore, is not so distinct; sometimes it scarcely shows. The hydrotheca is about $1\frac{1}{2}$ times as long as wide, projecting outward at an angle of 15°, and with the margin comparably oblique; the face is nearly straight; the intrathecal ridge is well marked, horizontal, and complete, slightly lower than the corresponding internodal septum. There are seven marginal teeth; the median tooth is small and rather sharp, the first lateral is slightly larger and blunter, the other two laterals are broader and rounded at the tip. The supracalycine nematophore is curved, reaching beyond the margin of the hydrotheca; the mesial nematophore is almost as long as the face of the hydrotheca; only a small, somewhat shovel-shaped portion is free.

Gonosome.—Not observed.

Type.—U.S.N.M. 43463.

Cladocarpus longipinna, n. sp.
Fig. 3

Trophosome.—Fragment of colony, 4 cm, was not branched; stem fascicled; hydrocladia up to 2 cm in length, slender, divided into long internodes that are strongly septate, usually eight or nine septa present. The hydrotheca is long and slender, gradually increasing in size from base to margin; face slightly convex; the intrathecal ridge is short, turned upward; the margin is horizontal. There is one short median tooth much longer than the others, of which there are six pairs, shallow and rounded to produce a wavy appearance. The supracalycine nematophores overtop the margin of the hydrotheca; the mesial nematophore is short, with the base adherent to the internode below the hydrotheca and the short free portion projecting out past the base of the hydrotheca; there is a definite joint at the base.

Gonosome.—The gonangia are oblong, with the tip curved over, and the opening pointing outward or downward; they grow in large numbers from the bases of the hydrocladia and from the stem nearby. The phylactogonia are of the staghorn type with two prongs, each regularly curved, with usually four points to each prong.

Remarks.—This species closely resembles *C. septatus* Nutting. It differs from it in having a fascicled stem, a longer and slenderer hydrotheca, with a greater number of small teeth on the margin, and in having simpler phylactogonia.

Type.—U.S.N.M. 43465.

FIG. 1.—*Eudendrium speciosum*, n. sp.: *a*, natural size; *b*, portion of colony showing hydrothecae and male gonophores (×20). FIG. 2.—*Aglaophenia longiramosa*, n. sp.: *a*, natural size; *b*, portion of hydrocladium with hydrothecae (×20); *c*, portion of hydrocladium with hydrothecae (×40). FIG. 3.—*Cladocarpus longipinna*, n. sp.: *a*, natural size; *b*, portion of colony showing hydrothecae, gonangia, and phylactogonia (×20); *c*, portion of hydrocladium with hydrothecae (×20); *d*, two hydrothecae (×40).

ZOOLOGY.—*Notes on the amphipod genus* Bactrurus *Hay, with description of a new species.*[1] CLARENCE R. SHOEMAKER, U. S. National Museum.

In proposing the generic name *Bactrurus* in 1902, Dr. William P. Hay (Proc. U. S. Nat. Mus. **25**: 430) said, "*C*[*rangonyx*] *mucronatus* Forbes is neither *Crangonyx* nor *Niphargus,* but belongs to a distinct genus for which I propose the name *Bactrurus.*" His proposition appears not to have been accepted, as subsequent students allowed the species to remain in *Eucrangonyx* where it had been placed by T. R. R. Stebbing in 1899 (Trans. Linn. Soc. London (ser. 2) **7** (pt. 8): 423). In 1940 Leslie Hubricht and J. G. Mackin (Amer. Midland Nat. **23** (1): 201) revived the genus and gave a diagnosis, which Hay had failed to do.

I am here giving a fuller description of some of the generic characters, and I am also describing a new species from a well at Topeka, Kans.

Description of Bactrurus.—Animal long and slender, with the first 4 coxal plates about as deep as their respective segments. Head rather long with evenly rounding lateral lobes. Eyes absent. Antenna one-half to two-thirds the length of the body; primary flagellum very long, accessory flagellum 2-jointed and very short. Antenna 2 much shorter than 1. Mandible, molar strong, accessory cutting plate complex, about 7 spines in spine-row, palp with second and third joints subequal in length. Maxilla 1, inner plate with 5 or 6 plumose setae; outer plate with 7 spine-teeth. Maxilla 2, inner plate with oblique row of plumose setae. Maxilliped, inner plate with 4 or 5 apical spine-teeth; outer plate with from 5 to 7 spine-teeth on inner margin. Gnathopod 1 shorter and stouter than gnathopod 2, palms armed with many stout, notched spine-teeth. Peraeopods 3 to 5 with second joint moderately expanded. Abdomen elongate. Metasome segments with lower hind margins broadly rounding. Urosome segments free. Uropod 3, outer ramus about as long as its peduncle; inner ramus rudimentary. Telson entire or with slight emargination. Stalked coxal gills occur on gnathopod 2 and peraeopods 1 to 5, but may be absent on peraeopod 5. Simple lateral sternal gills occur on mesosome segments 6 and 7 and may occur on metasome segment 1.

The two described species and the new species which I am here describing bear a close superficial resemblance, but they can be distinguished by certain characters, as follows:

Telson of male very long and cylindrical; telson of female extending beyond third uropods, slightly notched and armed with rather long spines. *mucronatus*

Telson of male extending slightly beyond third uropods, apex slightly convex, entire, and armed with many short spines; telson of female extending beyond third uropods, slightly notched and armed with many short spines. *brachycaudus*[2]

Telson of male and female not extending beyond third uropods, notched and armed with long spines .... *hubrichti*

Bactrurus mucronatus (Forbes)
Fig. 1

Crangonyx mucronatus S. A. Forbes, Illinois State Lab. Nat. Hist. Bull. No. 1: 6, figs. 1–7. 1876.
Crangonyx mucronatus O. P. Hay, Amer. Nat. **16**: 241. 1882.
Eucrangonyx mucronatus T. R. R. Stebbing, Trans. Linn. Soc. London (ser. 2) **7** (pt. 8): 423. 1899.
Bactrurus mucronatus W. P. Hay, Proc. U. S. Nat. Mus. **25**: 430. 1902.
Eucrangonyx mucronatus T. R. R. Stebbing, Das Tierreich, Amphipoda I: 388. 1906.
Eucrangonyx mucronatus A. L. Weckel, Proc. U. S. Nat. Mus. **32**: 29, fig. 2. 1907.
Bactrurus mucronatus L. Hubricht and J. G. Mackin, Amer. Midl. Nat. **23** (1): 201. 1940.
Bactrurus mucronatus L. Hubricht, Amer. Midl. Nat. **29** (3): 693. 1943.

Forbes's description and figures of this species, which he first discovered in a well at Normal, Ill., are very good, but I am here giving a figure of the anterior part of the animal and detailed figures of the gnathopods of the male. I am also figuring the mouth parts, which were not figured by Forbes.

The gnathopods of *B. mucronatus* have the palms slightly concave, and gnathopod 1 is

[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received October 31, 1944.

[2] HUBRICHT and MACKIN, Amer. Midl. Nat. **23** (1): 201, fig. 8. 1940.

shorter and appears to be somewhat stouter than 2. The mandibular spine-row contains 7 spines; second and third joints of mandibular palp subequal. Inner plate of first maxilla with 5 plumose setae; outer plate with 7 spine-teeth. Second maxilla with oblique row of plumose setae on inner plate. Inner plate of maxilliped is armed distally as follows: a sharp spine at the upper inner corner followed by a stout sharp spine-tooth, then a plumose or pectinate spine followed by a stout sharp spine-tooth and a curved spine; outer plate armed with 5 or 6 spine-teeth on inner margin.

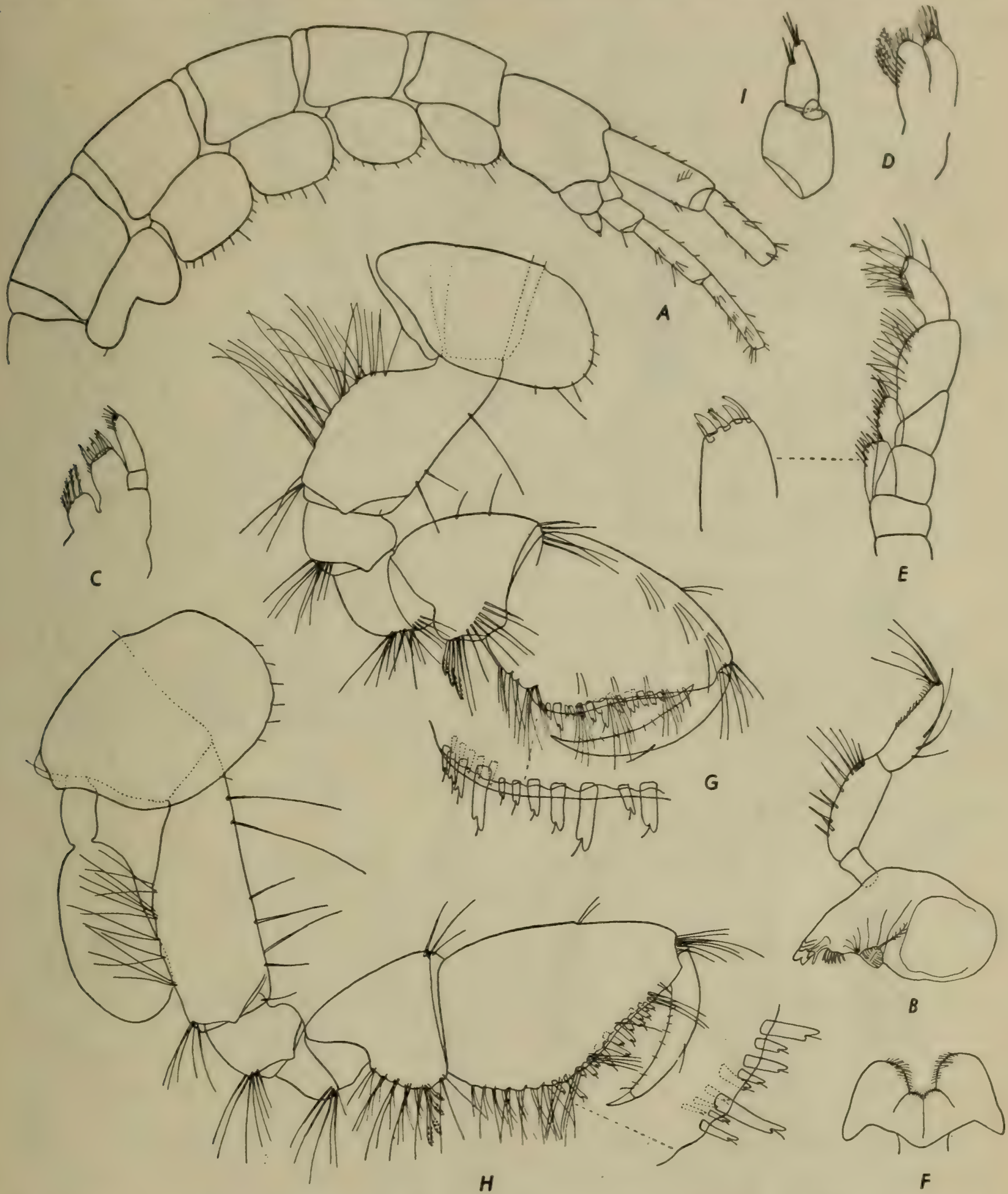


FIG. 1.—*Bactrurus mucronatus* (Forbes): Male: *A*, anterior half of animal; *B*, mandible; *C*, maxilla 1; *D*, maxilla 2; *E*, maxilliped; *F*, lower lip; *G*, gnathopod 1; *H*, gnathopod 2; *I*, uropod 3.

The outer ramus of uropod 3 is rather

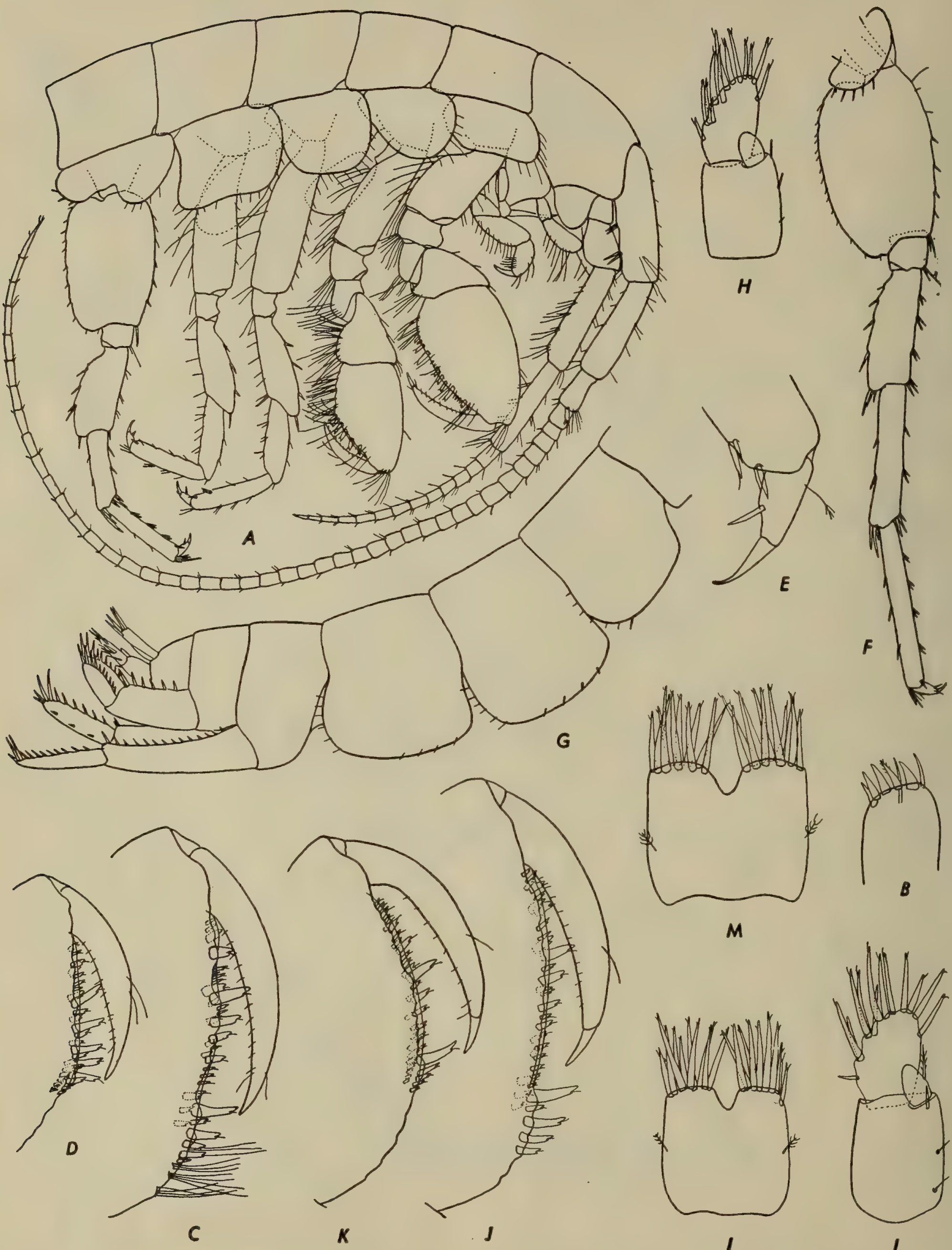


FIG. 2.—*Bactrurus hubrichti*, n. sp.: Male: *A*, anterior half of animal; *B*, apex of inner plate of maxilliped; *C*, *D*, palm of gnathopods 1 and 2; *E*, seventh joint of peraeopod 1; *F*, peraeopod 5; *G*, posterior half of animal; *H*, uropod 3; *I*, telson. Female; *J*, *K*, palms of gnathopods 1 and 2; *L*, uropod 3; *M*, telson.

slender, converges to the narrow truncate apex and is about as long as the peduncle; the inner ramus is very small and apparently unarmed. The telson of the male is very long and slender; that of the female is about twice as long as wide, slightly emarginate and armed distally with 2 groups of rather long spines. In the female the telson extends decidedly beyond the third uropods. Forbes says that the telson of the female is very similar to the telson of *Crangonyx gracilis*, but this is not correct, as the telson of *C. gracilis* in the female is somewhat wider than long and is cleft for about one-third its length. Coxal gills are present on the second gnathopods and the first 4 peraeopods but are not present on the fifth peraeopod in either sex. Lateral sternal gills are present on the sixth and seventh mesosome segments and may sometimes be present on the first metasome segment in either male or female. Forbes gives 9 to 10 mm as the length of the animal, but his specimens were apparently not fully grown, as some males in the national collection measure 16 mm from the front of the head to the end of the first uropods, and some of the females measure about 12 mm.

As no type has ever been designated for this species and as none of the original material appears to be extant, I am creating a neotype as follows: A male, U.S.N.M. 81546, taken from a well at Champaign, Ill., March 29, 1902.

Bactrurus hubrichti, n. sp.

Fig. 2

Male.—Antenna 1, peduncular joints decreasing consecutively in length; primary flagellum of about 40 joints, all of which except the first eight and the terminal joint bear small, slender sense clubs; accessory flagellum of 2 joints, the terminal joint very small. Antenna 2, fourth joint a little longer than fifth; flagellum shorter than peduncle and composed of about 13 joints. No sense organs present. Mouth parts very much like those of *B. mucronatus*. Maxilliped, inner plate armed distally as follows: at upper inner angle a sharp spine followed by two larger sharp spine-teeth, then a pectinate spine followed by another large sharp spine-tooth and a curved spine (Fig. 2, *B*); the outer plates in the male figured have 6 marginal spine-teeth on right plate and 5 on the left, but other males examined had as many as 7 teeth on a plate.

The first 5 coxal plates are as shown by Fig. 2, *A*. Gnathopod 1 perhaps a little shorter, but much stouter than 2. The palm of gnathopod 1 is slightly convex and that of gnathopod 2 is nearly straight. The armature of these palms is shown by Figs. 2, *C*, *D*. Peraeopods 1 and 2 subequal in length and alike in form; the seventh joint is strong and has a long sharp nail and a spine on inner margin. Peraeopods 3 to 5 increasing consecutively in length; the second joints bearing short spines on front and hind margins; seventh joints like those of peraeopod 1 and 2. Coxal gills are present on gnathopod 2 and all the peraeopods; lateral sternal gills are present on the sixth and seventh mesosome segments and the first metasome segment.

Metasome segments with lower hind margins broadly rounding and bearing short setae; and lower margin of segments 2 and 3 with a few short spines. Uropods 1 and 2 stout and very spinose, as shown by Fig. 2, *G*. Uropod 3 extends quite noticeably beyond the telson; outer ramus as long as peduncle and armed on outer margin with two groups of spines, each containing 3 spines, and a single spine proximally; inner ramus very small and without spines. Telson as long as wide; distal margin divided into two lobes by a shallow sinus, each lobe armed with about 10 long stout spines; lateral margins each with a central plumose seta. Length of male from front of head to end of uropod 1 about 21 mm.

Type.—A male, U.S.N.M. 80039, taken from a well at Topeka, Kans., by E. A. Popenoe, April 16, 1912.

Female.—The female closely resembles the male, the principal difference being in the second gnathopod. The palm of this gnathopod is convex, while that of the male is nearly straight. The arrangement of the spine-teeth of the gnathopods is shown by Figs. 2, *J*, *K*. The telson is a little wider than long, but otherwise like that of the male. Length of female from front of head to end of uropod 1 about 19 mm.

ICHTHYOLOGY.—Snyderichthys, *a new generic name for the leatherside chub of the Bonneville and Upper Snake drainages in Western United States.*[1] ROBERT R. MILLER, U.S. National Museum. (Communicated by LEONARD P. SCHULTZ.)

During a preliminary survey of the species of cyprinid fishes currently referred to the genus *Gila*, I made a detailed study of the pharyngeal teeth and arches of the leatherside chub, "*Gila*" *copei*. This species has been classified in six different genera: *Squalius* Bonaparte, *Leuciscus* Walbaum, *Tigoma* Girard, *Cheonda* Girard, *Richardsonius* Girard, and *Gila* Baird and Girard,[2] but my work indicates that *copei* belongs to none of these. Therefore, I am erecting a new genus for its sole reception.

Snyderichthys, new genus

Genotype.—*Squalius copei* Jordan and Gilbert.[3]

Snyderichthys differs from the other *Gila*-like fishes of the West principally in having only four teeth in the main row of each pharyngeal bone, instead of five on the left side and four on the right. I have examined the pharyngeals of 34 specimens of *S. copei* as follows: 5 from Provo River, at Provo, Utah (U.S.N.M. 125138); 10 from the same place (U.S.N.M. 41632); 10 from Little Wood River at Shoshone, Idaho (U.S.N.M. 48041 and 48111); 2 of the 3 types of *Squalius aliciae*, a synonym of *Snyderichthys copei*, from Provo River near Utah Lake (U.S.N.M. 27412); 5 from the Beaver River at Beaver, Utah (U.S.N.M. 15795); and the 2 types of *Squalius copei* from Bear River, Evanston, Wyo. (U.S.N.M. 27409). Despite published tooth counts, these fish (with two exceptions noted below) have only four teeth in the main row of each side. The dental formula varies in these specimens from dominantly 2,4–4,2 in the Bonneville system to dominantly 1,4–4,1 in the specimens from Little Wood River. The pharyngeals of the two types of *Squalius aliciae*, which previously had been examined (presumably by Jouy), were 2,4–4,2 and 2,4–3,2, the third tooth of the right arch of the second pharyngeal appearing to be enlarged as if representing a fusion of two teeth. This abnormality was also noted in one specimen from Little Wood River, which had a formula of 1,4–3,1. In the two types of *S. copei*, the larger specimen has the right arch missing (teeth 1,4 on left arch, the single tooth represented by a strong alveolus), and the smaller one lacks the left arch (teeth 4,1 on right arch, one tooth of the main row represented by a prominent alveolus). No other specimens from Bear River are at hand. *Snyderichthys* differs further from the fishes currently placed in the genus *Gila* in having the gill membranes attached very close together rather than comparatively wide apart.

Of the other known genera of cyprinid fishes in the Bonneville and Columbia River drainages with biserial dentition, only three have four teeth in the main row on each side. These are *Rhinichthys* Agassiz (including the subgenus *Apocope* Cope), *Oregonichthys* Hubbs, and *Couesius* Jordan. *Snyderichthys* differs from each of these genera in lacking a barbel and differs further from *Rhinichthys* in the absence of basal radii on the scales. The monotypic genus *Oregonichthys*, with very large specialized scales, is obviously distinct, and *Couesius* (as represented by the type of *greeni*, U.S.N.M. 44454) is likewise not closely related to *Snyderichthys*. So far as known, the new genus is monotypic, and it is confined to the basin of Pleistocene Lake Bonneville in Utah, Wyoming, and Idaho, the Upper Snake River of Idaho and Wyoming, and the Wood River drainage of western Idaho.

It is a pleasure to name this distinctive fish in honor of the late John Otterbein Snyder, in recognition of his pioneering work on western fishes. *Snyderichthys* takes its place among the peculiar cyprinid genera *Ictichthys* Jordan and Evermann, *Mylocheilus* Agassiz, *Acrocheilus* Agassiz, and *Oregonichthys*, which are confined to the Bonneville and Columbia River drainage basins.

[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received November 22, 1944.

[2] See JORDAN and EVERMANN, U. S. Nat. Mus. Bull. 47, pt. 1: 236. 1896; JORDAN, EVERMANN, and CLARK, Rep. U. S. Comm. Fish., pt. 2: 119. 1928 (1930); SIMON, Wyoming Wild Life **7** (4): 7, 1 fig. 1942; SIMON and SIMON, Univ. Wyoming Publ. **6** (4): 51, 61. 1942; TANNER, Utah Acad. Sci., Arts and Letters **13**: 160, 169. 1936.

[3] Proc. U. S. Nat. Mus. **3**: 461. 1880 (1881).

ICHTHYOLOGY.—Pygidium mondolfi, *a new catfish from Venezuela*.[1] LEONARD P. SCHULTZ, U. S. National Museum.

Recently, three specimens of a South American catfish, collected near Caracas, Venezuela, by Sr. Egardo Mondolfi and Sr. Vivas, were turned over to me for study. After careful comparisons were made with related species in the collections of the United States National Museum, it was concluded that these fishes represent a distinct species, and this is described below and named in honor of Sr. Mondolfi, through whose efforts the specimens were collected and forwarded to me. It is regretted that they were received too late to be included in my recent paper on *The catfishes of Venezuela* (Proc. U. S. Nat. Mus. **94**: 173–338, figs. 1–5, pls. 1–14. 1944).

Genus **Pygidium** Meyen

Pygidium mondolfi, n. sp.

Holotype.—U.S.N.M. 120377, a sexually mature male, 60.5 mm in standard length, collected by Sr. Egardo Mondolfi and Sr. Vivas, July 16, 1939, from Quebrado Chacaito near Caracas but in Estado de Miranda, Río Tuy system, Venezuela.

Paratypes.—U.S.N.M. 120378, 2 specimens, 45.5 and 33 mm in standard length, collected along with the holotype and bearing the same data.

Description.—Based on the holotype and two paratypes. Measurements, expressed in hundredths of the standard length, are recorded for the holotype then paratypes in parentheses, respectively. Standard lengths in mm. 60.5 (45.5; 33). The two longest specimens are sexually mature males.

Length of head 19.3 (19.8; 20.0); width across body at pectoral insertions 14.4 (15.4; 17.3), greatest depth of body 17.2 (18.5; 15.2); length of snout 7.28 (8.78; 7.88); diameter of eye 1.98 (2.20; 2.73); least width of fleshy interorbital 5.12 (4.62; 5.76); postorbital length of head 9.58 (10.5; 10.3); length of longest ray (first branched) of anal fin 10.4 (11.2; 10.0); longest dorsal ray 10.1 (11.2; 10.6); longest pelvic ray 6.62 (7.90; 8.18); longest (first) pectoral ray 10.6 (14.3; 13.9); longest caudal ray 12.2 (14.3; 14.8); least depth of caudal peduncle 10.6 (11.0; 11.2); length of caudal peduncle from base of last anal ray to midcaudal fin base 18.8 (20.4; 20.0); distance from tip of snout to origin of dorsal fin 65.3 (66.8; 66.7); snout to anal origin 75.3 (72.5; 74.2); snout to pelvic insertion 63.2 (58.6; 62.1); snout to anus 72.7 (68.6; 70.3); pelvic insertion to anal origin 13.4 (13.4; 11.5); length of upper maxillary barbel 8.27 (13.4; 13.0); length of lower maxillary barbel 6.62 (9.67; 9.09); length of nasal barbel 6.94 (10.8; 12.1); distance from edge of eye to margin of posterior nasal opening 1.98 (2.42; 2.42); distance from tip of first pectoral ray to pelvic insertion 37.2 (30.2; 30.3); distance that first pectoral fin ray projects beyond other pectoral rays 1.65 (2.20; 1.51); distance from dorsal origin to midcaudal fin base 32.7 (31.9; 30.6); anal origin to midcaudal fin base 26.4 (27.0; 26.4); pelvic insertion to midcaudal fin base 38.8 (40.1; 39.4).

The following counts were made, respectively: Dorsal rays, v, 5 (iv, 6; iv, 6); anal iv, 4 (iv, 4; iv, 4); pectoral i, 7-i, 7 (i, 7-i, 7; i, 7-i, 7); pelvic i, 4–i, 4 (i, 4–i, 4; i, 4–i, 4); branched rays of caudal fin 10 (11; 10).

Teeth all conical; anal origin under a vertical line through fourth branched dorsal fin ray; dorsal origin in front of a vertical line through front of anus; depressed dorsal fin reaches to opposite middle of depressed anal fin; pelvic fins not quite reaching to anus; pectorals much shorter than the head, the first ray little prolonged; nasal barbel reaches a little past the eye; upper maxillary barbel reaching about two-thirds the way to rear of opercle, and lower maxillary barbel a little shorter. The eye is in the anterior half of the head, the rear of orbit about equidistant between tip of snout and rear of head; the caudal fin is rounded or what may be considered as truncate-rounded, at least the middle rays are longest; dorsal and anal rounded; the pectoral fins are short and the first pectoral fin ray is barely prolonged; the dorsal origin is about equidistant between tip of caudal fin and base of pectorals; distance from midcaudal fin base to dorsal origin about 1.9 times in distance from tip of snout to dorsal origin; pelvic insertions about equidistant from midcaudal fin base and middle of length

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of pectoral fisn; distance between pelvic insertions and anal origin is contained from $2\frac{1}{3}$ to $2\frac{2}{3}$ times in distance from tips of pectoral rays to pelvic insertion.

Coloration.—A distinct interrupted dark brownish lengthwise streak, a trifle above the midaxis of body, formed of irregular-shaped dark brown blotches more or less elongate, these blotches with extensions of the pigment dorsally, sometimes reaching nearly to the back, but ventrally this streak of elongate blotches ends abruptly; below dark streak on the largest two specimens are minute brown specks, but lacking in the smaller specimen; above the dark lateral streak are numerous irregularly shaped brown blotches, less distinct and smaller than any forming the lateral stripe; area around nasal openings darkish; peritoneum white ventrally, dusky dorsally and laterally.

Remarks.—This new species belongs among those species of *Pygidium* with these characteristics: Conical teeth; a rounded or truncate-rounded caudal fin; the dorsal origin a little closer to midcaudal fin base than tips of pectoral rays; pelvic insertions a trifle closer to tips of pectoral fin rays than midcaudal fin base; with the eyes located just in front of middle of head length and the sides with a lateral streak of dark blotches. In this group *P. mondolfi* is related to the following:

In *P. dorsostriatum* Eigenmann, *P. latistriatum* Eigenmann, and *P. venulosum* Steindachner, the dorsal origin is farther forward so that it is equidistant between tip of caudal fin and some point on the head instead of near tips of pectoral rays as in the new species.

In *P. regani* Eigenmann the maxillary barbel reaches beyond the head, but in *P. mondolfi* it does not reach to rear of head.

In *P. striatum* Meek and Hildebrand, the pelvic insertion is equidistant between midcaudal fin base and rear of head instead of tips of pectoral rays as in *mondolfi*, and in the latter the barbels are much shorter, not reaching rear of head.

Pygidium mondolfi may be distinguished from other species of *Pygidium* reported from Venezuela by the following key:

1*a*. Caudal fin rounded or truncate-rounded, middle rays longest.

2*a*. Maxillary barbels slender, reaching to middle of pectoral rays; nasal barbel short, reaching a little past eye, or about halfway to end of operculum; origin of dorsal a trifle closer to base of midcaudal fin rays than to tips of branched rays of pectoral; insertion of pelvics equidistant between base of midcaudal fin rays and end of operculum; length of upper prolonged pectoral ray $1\frac{1}{2}$ times in distance from its tip to insertion of pelvics; a vertical line through origin of dorsal passes a little closer to insertion of pelvics than to anus; dark diffuse spots or blotches, no lateral band. . *Pygidium meridae* (Regan)

2*b*. Both maxillary as well as nasal barbels not reaching beyond three-fourths way to rear of opercle; origin of dorsal much closer to midcaudal fin base than tips of pectoral rays; insertion of pelvics an equal distance between base of midcaudal fin rays and rear of pectoral fin; length of upper or first pectoral fin ray $2\frac{1}{2}$ to 3 times in distance from its tip to pelvic insertions; a vertical line through dorsal origin passes about an equal distance between pelvic insertions and middle of anus; a dark lateral streak composed of dark brown blotches, with other smaller dark blotches dorsally. *Pgidium mondolfi*, n. sp.

1*b*. Caudal fin emarginate or a little concave.

3*a*. Color plain or sides with one or more continuous dark lengthwise bands, but no dark spots on back or sides.

Fig. 1.—*Pygidium mondolfi*, n. sp.: Holotype, U.S.N.M. 120377, from Quebrado Chacaito near Caracas, Venezuela. Ca. ×2. Drawn by Mrs. Aime M. Awl.

4a. Three dark bands, two on sides, one along middorsal line anteriorly; a wide diffuse blackish band along lateral line with wide pale streaks above and below; a second wide blackish band above upper pale band beginning at base of nasal barbel and passes through eye, thence along upper sides close to base of dorsal fin, thence fading posteriorly on upper sides of caudal peduncle; a third blackish streak separated from second black band by a pale streak runs along middorsal line of head and back, fading in front of dorsal fin; nasal barbel long, reaching past end of operculum; origin of dorsal equidistant between base of midcaudal fin rays and posterior one-fourth of length of branched pectoral rays; insertion of pelvics equidistant from base of midcaudal fin rays and middle of postorbital length of head or eye in young; length of prolonged upper ray of pectoral fin about equal to distance from its tip to insertion of pelvics; usually a more or less evident dark streak across outer two thirds of length of caudal fin.
Pygidium emanueli emanueli Schultz

4b. Three dark bands on sides, none along middorsal line of back anteriorly; a blackish band on midsides along lateral line, above and below which is a pale band or streak; below lower pale streak another band, more or less a series of diffuse blotches running together, beginning in axil of pectoral and continuing above pelvic base and fading posteriorly; a third intense dark band above upper pale streak, beginning at base of nasal barbel, passing through eye, thence a little distance away from base of dorsal, fading posteriorly; origin of dorsal fin equidistant from base of midcaudal fin rays and middle of length of branched rays of pelvics; insertion of pelvics equidistant from base of midcaudal fin rays and about middle of postorbital length of head; nasal barbel reaching past end of operculum; length of upper prolonged pectoral ray contained 1 to 1-1/7 times in distance from its tip to insertion of pelvics.
Pygidium emanueli motatanensis Schultz

4c. Color plain in adults, but in young about 30 to 40 mm or shorter a single black streak occurring along midsides, but at 70 mm streak barely discernible; origin of dorsal equidistant from base of midcaudal fin rays and tips of branched rays of pectoral; insertion of pelvics equal distance from base of midcaudal fin rays and middle of postorbital length of head; length of first (prolonged) ray of pectoral contained $1\frac{1}{2}$ to $1\frac{2}{3}$ in distance from its tip to insertion of pelvics; nasal barbel reaching a little past end of operculum; pelvics not reaching past anus.
Pygidium knerii Steindachner

3b. Back or sides or both with numerous blackish or brownish spots, these small or of moderate size; caudal fin a little concave; belly plain; sometimes spots along midsides more or less fusing into a dark, narrow streak; origin of dorsal a little closer to tips of branched rays of pectoral fin than to midbase of caudal fin; insertion of pelvics equidistant from midcaudal fin base and second third of postorbital length of head; length of upper prolonged ray of pectoral 0.9 to 1.2 times in distance between its tip and pelvic insertion; nasal barbel extends considerably past end of operculum.
Pygidium banneaui maracaiboensis Schultz

Obituaries

HARRY FIELDING REID, emeritus professor of dynamical geology and geography at the Johns Hopkins University, died on Sunday, June 18, 1944, just one month after his 85th birthday. Born in Baltimore, he took his A.B. and Ph.D. degrees at Johns Hopkins. After graduation he served successively as professor of mathematics and then of physics at Case School, returning to his alma mater in 1894 as lecturer, then as professor of geological physics, retiring in 1929. He is survived by his wife, Edyth Gittings, a son, and a daughter.

His was a long and distinguished career as a scientist as evinced by his early election to the National Academy of Sciences. He was devoted to the precise thinking and rigid demands of proof which doubtless grew out of his mathematical training and exercised a very salutary influence by both example and precept in the field of geology which is, to such a large degree, an eclectic science. Trips to Switzerland and Alaska to investigate glaciers and an absorbing interest led to his presidency of the Seismological Society of America and presidency of the Geophysical Union as well as to his appointment to the California Earthquake Commission and to that which made a study of the Panama Canal slides. Along with the late Joseph S.

Ames, he was sent to Europe during the early part of World War I to report on the contributions of British science to the war effort.

Dr. Reid was a member of the American Philosophical Society, the International Geodetic and Geophysical Union, Geological Society of America, Seismological Society, Société Hélvetique des Sciences Naturelle, International Seismological Association, Washington Academy of Sciences, Philadelphia Academy of Sciences, and others. He was Hitchcock lecturer in 1911.

He served his state as director of the Highway Division of the Survey for several years. He will be widely missed in all quarters where clear and precise thinking is practiced. It seems to me that the highest tribute that can be paid his memory is that all his life he was a high-minded gentleman and scholar.

EDWARD W. BERRY.

On June 3, 1944, "finis" was written to the many-sided crowded career of WILLIAM MALCOLM CORSE, a member of the Academy since 1923 and, at the time of his death, vice president representing the Society of Military Engineers. Brimming over with vitality, energy, and enthusiasm, Mr. Corse was an outstanding figure in American metallurgical circles for many years. He was born at Malden, Mass., in 1878, of New England parentage dating back to early colonial days. Twenty-one years later he was graduated from Massachusetts Institute of Technology. He soon turned from chemistry, his first interest, to metallurgy as a life career and during a period of 20 years (1902–1922) had a wide and varied experience. He held a number of metallurgical industrial positions of constantly increasing importance. Brass was seemingly his favorite, although nickel and bearing metals were close seconds. During World War I, on a special Navy civilian assignment, he spent much time at the Portsmouth, N. H., Navy Yard on brass foundry problems. His Washington career began in 1922 with the National Research Council and his special assignment of administrative work in connection with the International Critical Tables project. After 1925 he conducted a metallurgical consulting service in Washington in the course of which his ability to make and hold friends was strikingly demonstrated. He became well known in Army, Navy, and other Washington circles.

Mr. Corse's outstanding ability as a leader and organizer is well illustrated by the leading part he played in 1912 in the organization of the American Institute of Metals, now the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers. For 20 years he served either as the secretary-treasurer or secretary of this unit. He also served as the American corresponding secretary of the British Institute of Metals for many years up to the time of his death. For over 21 years he was a member of the metallurgical advisory committee of the National Bureau of Standards, where he will long be affectionately remembered. He played an important part in the organization of this committee by his close friend Dr. George Kimball Burgess, then chief of the Division of Metallurgy.

He was the author of the book *Bearing Metals and Bearings*, a pioneer in the field published as one of the technologic series of the American Chemical Society, as well as many technical papers dealing with metallurgical subjects. His many nonmetallurgical interests are illustrated by his membership in the Society of Colonial Wars, Sons of American Revolution, Arts Club of Washington, Cosmos Club, Rotary Club (Keene, N. H.), Society of American Military Engineers, and Army Ordnance Association.

Mr. Corse was married twice, and through the son of the daughter of his first wife his name is carried on. He is survived by his wife at the home, "Windy Hill," Westmoreland, N. H., to which he retired a few years ago when his health first became impaired. As a man who always rang true as the metal with which he worked and as a sympathetic friend with an earnest disposition to make others happy, he will long be remembered by his many associates in the metallurgical profession.

H. S. RAWDON.

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JOURNAL

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VOLUME 35 FEBRUARY 15, 1945 No. 2

BOTANY.—*A new form of the moonvine* Calonyction aculeatum *with divided corolla limb, and length-of-day behavior and flowering of the common form.*[1] H. A. ALLARD, Bureau of Plant Industry, Soils, and Agricultural Engineering.

The corolla limb of the moonvine *Calonyction aculeatum* is normally undivided. A form has been discovered differing from the typical form only by having the corolla limb divided into five (sometimes four) rounded, distinctly clawed segments. This distinctive form, which appears to have arisen as a mutant, seems worthy of a name and is diagnosed as follows:

Calonyction aculeatum (L.) House f. **apopetalum** Allard, forma nova

Limbus corollae in segmenta 5 (interdum 4) unguiculata divisus.

Type material has been deposited in the U. S. National Herbarium under the number 1871928. Isotypes have also been deposited in the general herbarium collection and the herbarium of introduced plants under the numbers 1871929 and 1871930, respectively. An abundance of herbarium material of the original type plant has been distributed among other large herbaria in the United States, including the Herbarium of the National Arboretum at Beltsville, Md., and the Gray Herbarium at Harvard University.

ORIGIN OF THE NEW FORM

For many years I have grown a number of moonvines each summer at Arlington, Va. As this vine is a native of the American Tropics, where cold is never experienced, the plants are not constituted to withstand winter severity at any stage in northern latitudes. A few plants, however, usually appear spontaneously each spring in my garden. The survival of such seeds seems to be favored by the very hard, impermeable seed coat and the protection afforded by an abundance of leaf litter, which may sometimes accidentally cover and protect them from freezing.

In October 1943 a vigorous seedling appeared in my garden under such circumstances and was left undisturbed until some time in November. For a brief period it was covered with a bucket to protect it from frost; then when it had begun to show signs of injury from the cold nights it was transplanted to a bucket in the warm greenhouse. Here it grew vigorously throughout the winter but showed no evidence of flowering until late in March and April, when the first buds appeared. Early in May 1944 the plant was transferred from the bucket to a spot in my garden where it could climb a high wire fence.

The first open blossom appeared on the evening of June 20. From this date new flowers appeared nightly, their number increasing throughout July and August, and on several nights as many as 45 flowers were displayed at one time. The first ripe seed pods appeared on July 7, the seed coat being mostly brownish in color. The usual color is a uniform black, but some plants produce seeds with entirely white seed coats. In all, 1,015 blossoms appeared on this vine up to and including September 16. Few blossoms appeared after that date.

The corolla limb was divided usually into five broad, rounded, distinctly clawed segments. Only four blossoms departed from this form, these being distinctive in having four segments. The twist of the lobes in the

[1] Received October 12, 1944.

bud is similar to that of the normal form, the direction of twist being clockwise, or from right to left. The pollen grains, as in the normal form, average about 160.15μ in diameter, ranging from 144μ to 165.6μ.

The moonvine normally produces five exserted stamens, which are adnate to the corolla tube, a stamen being situated below or in line with each sinus. In those blossoms having only four lobes, however, or four sinuses, the stamens are always four in number.

Numerous cuttings have been rooted from the original plant and cross pollinations with the normal unlobed form have been made to determine the genetic behavior of the mutant form. An abundance of selfed seed has also been obtained from the original plant, since it was induced to flower very early outdoors and has continued to flower until fall. The moonvine normally does not flower around Washington, D. C., until late in July or August when grown from seeds planted outdoors in May.

LENGTH-OF-DAY BEHAVIOR OF THE MOONVINE

The length-of-day behavior of the moonvine appears to be typical of that of many tropical plants, since it can flower in response to days only 12 hours long at the Equator and also during the much longer days that prevail during the warm growing season in middle latitudes.

Experiments carried out 15 or 16 years ago with seedlings subjected to various constant lengths of day from April 17, the date of germination, have revealed that days much below 12 hours in length may be unfavorable to flowering. The plants experiencing a 10-hour day never flowered, while the plants experiencing a 12-hour day and the controls experiencing full day began flowering July 27. The plants experiencing full day showed indications of becoming less floriferous and finally ceased flowering in September. Since this behavior may have been considered the result of aging, or a response due to lowering temperatures, further studies were made. To test this point a plant was transferred to a large bed of soil in the warm greenhouse September 27. This plant remained in a vigorous growing condition throughout the winter, but buds did not appear until March 29.

The plants experiencing the 10-hour day, which had never flowered, were also brought into the warm greenhouse and given the same conditions. These plants likewise failed to produce buds until April.

The mutant form that germinated in October showed the same nonflowering tendency throughout the winter, since in the warm greenhouse buds did not appear until late in March and early in April, a period of at least 162 days. Experiments have shown that normal plants will flower at Washington, D. C., in summertime when planted outdoors in about 100 days, which is about two months sooner.

This would indicate that the moonvine may show a more or less intermediate behavior in its flowering, since days as short as 10 or 11 hours do not appear favorable to free flowering. Whether there are upper limits with days too long for flowering is not known. A length of day of 14.9 hours from sunrise to sunset, which is the longest day prevailing in the Washington area, does not appear to be very unfavorable to flowering when earlier flowering has been induced.

OTHER CHARACTERISTICS

The moonvine is a very ornamental climber and a worthy addition to any garden. Its big, immaculately white flowers, exhaling a delightful perfume, opening at dusk and enduring until the next morning, always excite admiration in the lover of flowers. The flowers appear to self-pollinate very readily, as the anthers, usually closely investing the stigma in the bud, have dehisced and exposed their large pollen grains even before the flowers have actually expanded their corollas. If plants can be started in the greenhouse in winter and grown to good size before transplanted into the garden in May, flowering can be induced a month or more in advance of those grown from seed outdoors.

The common peduncle of the flowers and the pedicels of the individual blossoms show a strong negatively geotropic behavior, and so the buds and flowers are usually held stiffly erect. After flowering and pollination the thick, enlarged pedicel of the

opened blossom bends downward sharply under the influence of a positive geotropism, causing the enlarging, immature capsules to point earthward. This positive geotropism affects only the individual maturing blossoms of the cluster. Experiments have shown that when the stamens are removed and fertilization is prevented, the pedicels do not bend earthward, and after yellowing they finally dehisce at the base and fall off.

The moonvine under normal summer conditions is a nocturnal flowering plant and in warm weather opens its flowers in the evening some time after sundown. The flowers soon wither the next morning. As the autumn days approach and cooler weather intervenes, the opening of the flowers may be retarded. When the night temperatures become too low the time of flowering is completely reversed. The plants then behave like the morning-glories, their flowers opening only during the day and persisting even until the next day.

During the warm days of late summer the nocturnal flowering of the moonvine is a very persistent behavior. Some years ago I cut off the main stem of a large flowering plant at the ground and noted its subsequent behavior. This plant continued to open its blossoms in the evening at the normal time for one or two evenings until profound wilting had set in.

It would be of some interest to know whether the flowering of the moonvine is seasonal and becomes reduced in the tropical and subtropical conditions of its native home when the shortest days prevail.

As previously stated, flowering outdoors becomes noticeably reduced in September, but lower temperatures conceivably might be an unfavorable condition here. However, plants kept in a greenhouse with warm summer temperatures still tend to become nonflowering. Some change in light conditions appears to be responsible for this behavior. Not only do greatly shortened days intervene in wintertime, but also there is reduction in ultraviolet and other qualities of radiation in the greenhouse during the winter months in temperate regions. Furthermore, there is a great reduction in intensity of radiation throughout the win-

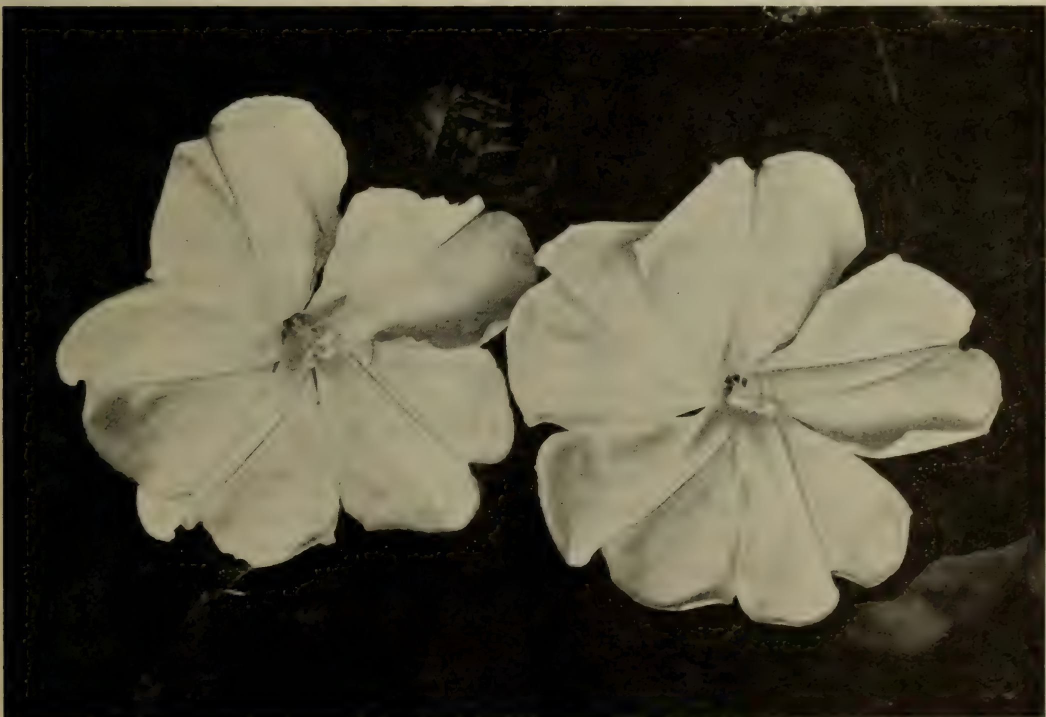


Fig. 1.—Blossoms of mutant form of moonvine, *Calonyction aculeatum* f. *apopetalum;* 0.58 natural size.

ter, since the average maximum intensity is perhaps less than 1,000 foot-candles in comparison with an average of 10,000 foot-candles in summertime. It is evident, then, that while a shortened length of day may appear to explain the nonflowering tendency of the plants in wintertime, this may not be the only factor involved at this season. The failure of the plants to flower under daily durations of summer sunlight of 10 hours, as tests have shown, would appear to be correctly explained as a length-of-day response.

While the moonvine is highly regarded in our gardens only for its beauty, the natives of Central America long ago somehow learned that a decoction of the macerated plant would coagulate the latex of the castilla tree in the production of its rubber. This coagulating characteristic has been studied and a resin has been isolated[2] that may find use in the commercial production of castilla rubber.

The scientific name *Calonyction* is a most appropriate one for this lovely flower, being a compound of the Greek words *kalos*, beautiful, and *nyktios*, nightly, meaning beautiful at night. Surely the flower deserves this characterization.

The flowers are so very fragrant during the warm summer nights that their delightful perfume can be detected some distance from the plants. However, during the cool autumn days and nights the blossoms are almost entirely devoid of fragrance.

[2] Wildman, S. G., McMullan, A. V., and Griggs, Rosamond, *Isolation of an active substance from* Calonyction aculeatum *capable of coagulating castilla latex.* Science **97**: 471–472. May 21, 1943.

BOTANY.—Dipterocypsela, *a new genus of Vernonieae from Colombia.*[1]

S. F Blake, Bureau of Plant Industry, Soils, and Agricultural Engineering.

A composite from a little-known area in interior Colombia, referred to me for study by E. P. Killip, of the U. S. National Herbarium, proves to represent a new genus of Vernonieae with somewhat remarkable features of involucre, corolla, and achene.

Dipterocypsela Blake, gen. nov.

Capitula homogama discoidea multiflora. Involucri hemisphaerici phyllaria ca. 3-seriata gradata, extima parva linearia subherbacea saepe cornuta, media oblonga submembranacea margine subscariosa plusminusve concava apice cucullata dorso infra apicem herbaceo-cornuta, intima ovata submembranacea plana inappendiculata. Receptaculum planum nudum. Corollae irregulares 5-fidae, fauce campanulata tubum subaequante, limbo bilabiato, labio exteriore e dentibus 2 longioribus, interiore e dentibus 3 brevioribus constante. Antherae apice appendicibus ovatis praeditae, basi alte sagittatae, auriculis obtusis ecaudatis, eis contiguis connatis. Styli rami anguste lineari-subulati hispiduli. Achenia (immatura) late ovalia valde obcompressa saepius bialata, facie interiore 4-costata exteriore 3-costata, alis (una vel ambabus) saepe in cornua productis. Pappus pluriseriatus gradatus fragilis deciduus e setis numerosis hispidulis compositus.—Herba elata succulenta apice bifurcata inconspicue pilosula pilis appressis; folia ampla late ovata repande paucidentata (suprema integra) penninervia sicc. membranacea olivaceoviridia longe petiolata petiolis supra alatis; capitula mediocria numerosa in spicis scorpioideis longis nudis pedunculatis basi interruptis axillaribus v. extra-axillaribus et terminalibus disposita; corollae purpureae. Species typica *D. succulenta*, sp. nov.

Dipterocypsela succulenta Blake, sp. nov.

Herba 2.5 m alta, basi invisa, partis novellis cinerascentibus. Folia inferiora magna, petiolo 9–20 cm longo infra nudo supra cuneate alato, ala interdum 1–2-dentata, lamina late ovata ca. 30 cm longa et lata acuta basi subtruncata vel obscure cordata paucidentata et inter dentes vix evidenter multidenticulata dentibus venulas terminantibus obtusis glandulosis inter se saepius 1.5–3.5 mm distantibus penninervia nervis 8–10-jugis apice curvato-anastomosantibus albidis; folia media minora, basi rotundata; folia suprema multo minora integra v. subintegra, petiolo 1.5–4.5 cm longo, lamina 7.5–11.5 cm longa, 5.5–8.5 cm lata. Pedunculi saepius 5.5–9 cm longi; spicae 8–30 cm longae, duabus terminalibus equalibus v. inaequalibus. Capitula ca. 26-flora basi lata sessilia ebracteata ca. 1 cm diam. 7 mm alta, vel florentia

[1] Received December 14, 1944.

(sicca) ca. 20 mm diam. 8 mm alta. Phyllaria extima ca. 5 anguste linearia ca. 4 mm longa 0.5 mm lata laxa apice saepe breviter herbaceo-cornuta vel cucullata; media ca. 4 oblonga ca. 6.5 mm longa obtusa submembranacea dorso viridescentia margine et apice subscariosa plusminusve concava apice saepe cucullata infra apicem cornu dorsali obtuso molliter herbaceo recte patente donata; intima ca. 4 late ovata ca. 8 mm longa, 4.5 mm lata, obtusa apice paullum erosa submembranacea dorso viridescentia margine et apice subscariosa

FIG. 1.—*Dipterocypsela succulenta*, from the type: *a*, Apex of plant, ×½; *b*, upper part of stem, ×½; *c*, *d*, phyllaries of outermost series, ×5; *e*, *f*, phyllaries of middle series, ×5; *g*, phyllary of inmost series, ×5; *h*, corolla in side view, ×5; *i*, corolla spread out, ×5; *j*, 3 stamens, ×5; *k*, style, ×5; *l*, achene, ×5; *m*, pappus bristle, ×10.

paene ad apicem breviter ciliata ut phyllaria cetera dense cinerascenterque pilosula pilis appressis; omnia margine et apice saepe purpureo-tincta. Corollae purpureae ca. 8 mm longae, saltem exteriores horizontaliter patentes tubo stamineo et stylo sursum curvatis; tubus tenuis ca. 2.5 mm longus glaber; faux campanulata ca. 2.5 mm longa glabra; dentes apice recurvati dorso prope apicem praecipue juventate stipitato-glandulosi, ei labii exterioris 3 mm ei labii interioris 2 mm longi. Achenia valde immatura ca. 1 mm longa 1.5 mm lata (alis tenuibus ca. 0.25 mm latis inclusis) truncata glabra. Pappi albi setae ca. 56, exteriores ca. 1.5 mm interiores 3 mm longae.

COLOMBIA: Erect succulent herb to 2.5 meters high, flowers purple, showy, in dense colonies on masses of broken limestone in forest 5 km south of Codazzi, Dept. Magdalena, alt. ca. 150 meters, 31 Oct. 1943, *Oscar Haught* 3796 (type no. 1708581, U. S. Nat. Herb.).

The proper position of this plant in the tribe Vernonieae is not easy to determine. Bentham and Hooker's series Ethulieae, containing 11 genera, was separated from their series Euvernonieae, containing 6 genera, by no definite character aside from the pappus. In the Ethulieae the pappus was described as absent or composed of very caducous and usually few bristles, in the Euvernonieae as more or less persistent and usually 2–3-seriate, with copious inner bristles. Hoffmann, in Die natürlichen Pflanzenfamilien, split the Ethulieae into two groups, the first without pappus, the second with a pappus of caducous ("leicht abfallenden") bristles, but did not assign them the dignity of series names. In this, as in some similar cases in other groups of Compositae, it is not too easy to discriminate between a caducous pappus, one that is fragile and readily deciduous, and one that is definitely persistent. Moreover, some species of *Vernonia* and related genera of the Euvernonieae possess a pappus that is quite as fragile and as readily deciduous as that of *Erlangea* and *Blanchetia* (of the Ethulieae).

For the present the genus may be placed after *Vernonia*. It differs primarily from that genus, as from all other known Vernonieae, in its truly winged and strongly obcompressed achenes. Its bilabiate corollas and curiously appendaged phyllaries are additional points of distinction. The presence of an outer lip made up of two petals instead of three is certainly very rare in Compositae, but repeated and careful dissection seemed to leave no doubt of its reality.

The immature state of the achenes makes a complete description of their characters impossible. Those of the two or three outer series of flowers are normally although not invariably winged as described; the very immature inner achenes show no evidence of a wing. Several instances of connation between two ovaries of the same series, and in two cases even between three, were observed in the material dissected; these immature fruits were much broader than normal ones and showed two circles (in two cases three) of more or less completely detached pappus bristles at apex. In one instance two corollas were found in place on a double ovary, and in another three embryos, one much smaller than the others, were found in place in a triple ovary.

ENTOMOLOGY.—*The mealybug genus* Heterococcus *Ferris and some of its relatives* (*Homoptera: Coccoidea*).[1] HAROLD MORRISON, Bureau of Entomology and Plant Quarantine.

First described in 1918 by Ferris (4, p. 65), *Heterococcus* has attracted little attention in the years since its description, and only a few species have been assigned to it during this time. In fact the genus has been so infrequently recognized that for most of this period no examples of any species belonging to it have existed in the United States National collection of Coccidae. While a few specimens have become available in recent years, this situation was modified only during the summer of 1944, when specimens in numbers from an infestation of one species on timothy were sent in for examination from Wooster, Ohio, and when this same species was found on foxtail inside the city of Washington, D. C.

After reviewing the descriptions of the species that have been assigned here, it appears reasonably certain that this recently collected insect is undescribed, and since it has been reported from an important forage

[1] Received December 11, 1944.

plant, the name and description here presented may prove useful to economic entomology. At the same time a review of the other species assigned to the genus is attempted, although this, of necessity, is based mostly on literature and not on actual specimens of the species involved and so undoubtedly possesses the deficiencies of work so based. Through the much appreciated courtesy of Prof. G. F. Ferris, it has been possible to examine a specimen from the type material of the genotype, *Heterococcus arenae* Ferris, and supplementary descriptive notes and figures for this species, as well as a broadened generic diagnosis, thereby have been added to the paper. The illustrations accompanying the paper were drawn by Mrs. Sara Hoke DeBord.

GENERIC RELATIONSHIPS OF HETEROCOCCUS

There exists at present so much confusion respecting the characteristics and limits of the various genera that have been described among the mealybugs that any suggestions or conclusions that may be offered in this restricted study must be accepted as tentative or preliminary. Professor Ferris in his initial presentation of this genus stressed the combination of the characters 9-segmented antennae, tarsal claw with denticle, and presence of circular pores only in the dorsal derm as a basis for generic recognition. With some additions and elaboration these still seem to present the most significant characteristics of the group of species involved.

To anyone who has examined numbers of mealybugs, the outstanding characteristic of this genus surely will be the numerous circular multilocular disk pores, normally quinquelocular, that are distributed widely over both surfaces of the body and that appear obviously to represent an alternate to the small trilocular (and usually triangular) disk pores that may be called a normal feature of mealybug anatomy. These circular pores are so distinctive that they must have some classificatory significance, and on this account consideration has been given to certain other mealybugs that are known to possess them in comparable striking fashion. Possibly additional species in the mealybug group beyond those discussed should be considered, but many of the specific descriptions are too incomplete to permit accurate recognition of their relationships.

First in line for consideration is one of the species originally described in the genus *Heterococcus*, *H. painei* Laing (15, p. 20). This species, while conforming with some elements of the original generic characterization, is described as lacking any definite indications of cerarii, such as the paired spines on the anal lobes of the genotype, and as possessing a single transverse ventral cicatrix (or circulus), a structure not found in any of the species here considered to belong properly in the genus. The stout oval body of *painei* and its very different habitat, on coconut in the South Pacific, also contribute to the conclusion that it would be best to exclude the species from *Heterococcus*. On the basis of present imperfect knowledge of mealybug generic standards, a new genus for this species would seem to be indicated and is described in this paper.

A second species in which the quinquelocular pores are numerous and conspicuous, and which possesses other characteristics of *Heterococcus*, as 9-segmented antennae, cerarian spines, and denticulate claw, is the one described as *Pseudococcus flagrans* by Brain (3, p. 140). Although it is so similar to *Heterococcus*, it became evident, in the process of checking literature, that *flagrans* is congeneric with and closely related to *Annulicoccus ugandensis* James (13, p. 209), having the same 9-segmented antennae, the same row of four ventral cicatrices down the ventral abdominal midline, and, from James's illustration, an even greater abundance of large quinquelocular and smaller multilocular disk pores. Surprisingly, however, while James in his generic discussion states flatly that the claw lacks a denticle, this, as indicated above, is definitely present, and sometimes almost conspicuous, in specimens of Brain's species. From examination of many species in the so-called *Phenacoccus* series of mealybug genera it has seemed that the presence of a claw denticle (usually in association with 9-segmented antennae) was positively significant as evidence of a segregation group including several genera. Even if the presence or absence of a claw denticle is actually without classificatory significance in *An-*

nulicoccus, the genus certainly seems to be a sound morphological and ecological segregate with the two species here associated in it.

The presence of more or less enlarged, circular, usually quinquelocular pores has been reported for several species of *Ripersia*, but, so far as has been ascertained, only one of these, *Ripersia asphodeli* Bodenheimer (1, p. 178) appears to approach *Heterococcus* in respect to the abundant development and very wide distribution of the quinquelocular pores. In this species, on the basis of specimens supplied by Dr. Joseph Carmin, the large quinqueloculars (many actually are quadrilocular, or sometimes even trilocular) are heavily distributed over the body, especially along the margin and towards the apex of the abdomen, there is a distinct claw denticle, apical cerarii are developed and no ventral cicatrix or circulus is present. To this extent the insect is very strongly suggestive of *Heterococcus*, but the antennae are reduced to six segments, a few normal, small trilocular, pores are present, chiefly in the developed cerarii, and there are none of the large multilocular disk pores which occur in most of the species of *Heterococcus*. The situation of this species seems to be comparable to that of *H. painei*, already discussed, in that its characteristics, on the basis of our present knowledge of mealybug generic standards, appear to entitle it to segregation in a distinct generic unit; certainly it stands out as sharply as *Brevennia* and *Lacombia* separated from *Ripersia* as subgenera by Goux (10).

Accordingly, it has seemed best, in spite of the fragmentary character of this study, to establish a new genus for this anomalous species.

These various genera, so far as our present knowledge goes, may be separated from all other described mealybugs by the presence in the derm, both dorsally and ventrally, of numerous, circular, usually quinquelocular (but the loculi may range from three to six or more) disk pores, these occupying the place of the characteristic small trilocular pores of most mealybugs, with the triloculars either wanting entirely or greatly restricted in numbers and distribution.

The key below is offered for the separation of the four genera under discussion.

Genus **Annulicoccus** James

Adult female.—Thinly coated with white secretion, without cerarian tassels, body color pinkish, size medium (length 2–4 mm), elongate elliptical, length more than twice width, wholly membranous. Antennae 9-segmented, as in *Heterococcus*. Eyes approaching hemispherical, with only a small asymmetrical sclerotized base. Legs a little thickened, an obscure pattern of widely scattered tiny pores more or less developed on femur and tibia, these lacking on coxa, claw with or without denticle, tarsal digitules slender, acute, attaining or exceeding claw apex, claw digitules slender, slightly knobbed apically, slightly exceeding the claw apex. Beak very short conical, incompletely 2-segmented. Spiracles not unusual, with both quinqueloculars and multiloculars associated with each. Dorsal ostioles developed, not conspicuous, lips with some pores and setae. Cerarii not sharply developed, superficially with only the apical two or three pairs obvious, these each with two (rarely one) lanceolate spines and numerous rather long and stout setae and quinquelocular-type pores associated; actually (at least in *flagrans*) with 16 or 17 pairs of cerarian structures, each, except posterior as stated,

Key to Heterococcus and Associated Genera

a. One or more ventral cicatrices present.

- *b*. A single transverse ventral cicatrix; no traces of cerarii, not even one or a pair of slender spines in any cerarian area; multilocular disk pores few, restricted to midventral areas of last three segments . . . . *Laingiococcus*, n. gen.
- *bb*. Four conspicuous, circular to transversely elliptical ventral cicatrices in a row down ventral midline of abdomen; definitely recognizable cerarian spines present, on anal lobes at least; multilocular disk pores much more abundant, in wide bands on ventral surface of posterior abdominal segments and in irregular rows dorsally; quinquelocular-type pores distinctly larger than multiloculars . . . . *Annulicoccus* James

aa. No ventral cicatrices present.

- *c*. Antennae normally 9-segmented; no trilocular (triangular) pores present; multiloculars usually present, lacking in one species . . . . *Heterococcus* Ferris
- *cc*. Antennae 6-segmented; a few trilocular pores present in cerarii and widely scattered elsewhere; multiloculars lacking . . . . *Asphodelococcus*, n. gen.

with a single slender, lanceolate spine and several setae and quinquelocular-type pores. Anal lobes not developed, at most a faint bulge, no ventral thickening or any sclerotized area. Anal ring approaching the normal pseudococcine type, but the outer pores definitely circular in shape, loosely arranged in middle of row, bunched at ends, pores of inner row more tightly bunched throughout, this row shorter than outer; with six setae, the longest a little shorter than apical anal lobe seta. Four types of derm pores present, all in numbers: Large quinquelocular-type with range of four to six or even nine loculi, multiloculars, here smaller than the quinquelocular-type, much smaller short tubulars, expanded at inner ends, and finally very tiny, short, cylindrical, simple pores; no normal triloculars and no normal elongate, slender tubulars. Body setae numerous on both surfaces, varying strongly in size, stiff basally but tapering to delicate tips. Characteristically four circular to transversely stout elliptical ventral cicatrices, posterior smallest, located on the midline seemingly in the interspaces between the second to sixth segments.

Type of genus.—*Annulicoccus ugandensis* James (13, p. 209).

The preceding description has been based, in part, on specimens of the second species included, that is, *flagrans* (Brain), since the description of *ugandensis* omits mention of a few of the characters considered.

The two species now included may be separated by the following key:

a. Claw without denticle; large quinquelocular-type pore described as actually with 6 to 9 loculi . . . . *ugandensis* James
aa. Claw with distinct denticle; quinquelocular-type pore actually normally with 5 loculi. *flagrans* (Brain)

The preceding discussion and the accompanying illustrations (Figs. 6, 14–21) of *flagrans*, drawn from specimens from Brain's type material, should serve not only to fix the generic characters clearly but also to present descriptive details beyond those provided by Brain in his original description of this species (3, pp. 140–143).

Asphodelococcus, n. gen.

Adult female.—Secretionary covering uncertain, body color pink, size medium, length around 3 mm, elliptical, wholly membranous. Antennae 6-segmented, apical segment much longer than any other and with four sensory setae. Eye somewhat rounded and on a flat, asymmetrical, basal collar. Legs normal but small and a little thickened, posterior without pores on coxa or femur, a few scattered on tibia, claw denticle distinct, tarsal digitules acute, not exceeding claw apex, claw digitules faintly knobbed apically, surpassing claw apex. Beak stout conical, wider than long, incompletely 2-segmented. Spiracles not unusual. Both pairs of dorsal ostioles present. Only the posterior two or perhaps three pairs of cerarii plainly developed and recognizable, but others along the body margin vaguely indicated, developed cerarii including slender spines, trilocular pores, and spinelike accessory setae, smaller than spines, but otherwise hardly differentiated. Anal lobes indicated by rounded bulges, no ventral thickening, apical setae of moderate length. Anal ring approaching normal pseudococcine type, with two rows of pores on each half, and with six setae, the longest a little shorter than apical seta. Three types of pores present, normal small triloculars scattered in small numbers, large quinquelocular-type, with three to six loculi, very numerous and crowded, and small tubular ducts with inner ends thickened and swollen and externally protruding openings; no multiloculars. Dorsal body setae small, almost spinelike, scattered, inconspicuous in midst of pores, ventral considerably longer and more slender, but few and likewise inconspicuous. No ventral cicatrix.

Type of genus.—*Ripersia asphodeli* Bodenheimer (1, p. 178).

This is the only species at present known to possess any close approximation to the above combination of structural characters. From literature, *Lacombia* Goux (10, p. 62), based on the species *Ripersia bouhelieri* Goux (9, p. 199), possesses certain characteristics indicating possible relationship, since it lacks multilocular disk pores, but does have triloculars, quinqueloculars, and tubular ducts with protruding openings. However, there is no evidence from the description that the quinqueloculars occur in abundance as with this genus, the apical antennal segment is not so conspicuously elongated, there is no claw denticle, the body setae are comparatively very numerous, the anal ring is unusual, with the pores in the bands reduced in size and mostly widely separated, no cerarii are developed, and at least one ventral cicatrix is present. Certainly it is preferable to let these two stand as independent generic units until

much more knowledge on mealybug classification has accumulated.

The following descriptive details on the species *asphodeli* are supplementary to those given above in the generic description, and both should be used together for specific recognition.

Asphodelococcus asphodeli (Bodenheimer)
Fig. 1–5, 7–13

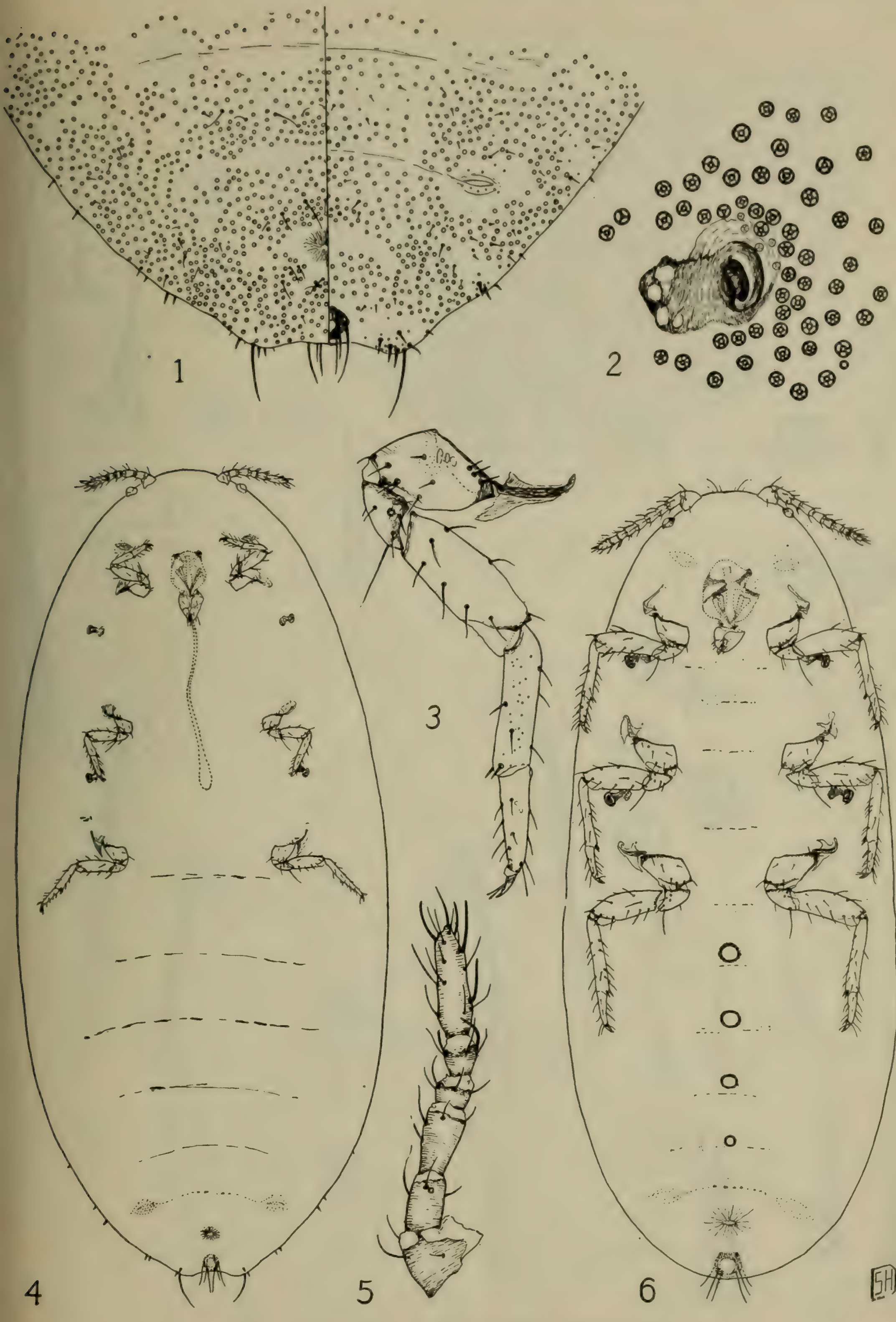
Adult female.—As mounted, elongate elliptical, maximum observed length 3.25 mm, width 1.6 mm. Antennal segments in microns: I, 40–44; II, 36–40; III, 44–48; IV, 18–20; V, 23–24; VI, 64–70 (four antennae); preapical segment with a single long, slender, somewhat curved sensory seta in addition to the four similar ones on the apical segment. Lengths of parts of a posterior leg in microns: Trochanter, 52; femur, 112; tibia, 100; tarsus, 68; claw, 17; tarsal digitules, 20; claw digitules, 20; a few large indistinct areolae on coxa, pores on tibia 12–16; small, widely scattered; leg setae small, stiff. Observed beak dimensions: Length 62–72μ, width 76–80μ, with proportions maintained. Spiracles stout, but not enlarged, the bar with wide sclerotized extensions; posterior a little larger than anterior; a definite pore cluster around the opening of each spiracle, including 2–5 small triloculars immediately adjacent to outer margin of opening and a much larger number (25–50) of quinquelocular-type pores around three sides. Each dorsal ostiole centered in a roughly circular dermal area, of considerable size, free of the large quinquelocular-type pores; pore and setal association with the individual lips variable, from one tiny trilocular pore to as many as six, and from usually no setae to an observed maximum of two small, stiff ones. Only the two posterior pairs of cerarii sharply defined, each comprising two slender, faintly lanceolate spines about 19μ long, perhaps 12–15 (apical) or 6 to 10 (penultimate) small triloculars and around five short, stiff setae of varying sizes, some hardly distinguishable from the paired spines, all loosely grouped in a marginal area of appreciable size devoid of the large quinquelocular-type pores; other abdominal segments with suggestions of cerarian development involving similar rather distinct cleared areas and one to several small spines or setae plus a few small triloculars; parallel obscure hints at cerarian development anteriorly, but here intermingled directly with the large quinquelocular-type pores, not in cleared areas. With a very small, irregular, sclerotized area around the bases of the cerarian spines of the anal lobe, apical seta about 120μ long, ventral subapical about 42μ. Anal ring small, the pores in the outer row approximately circular, separated by interspaces except at ends; pores in inner rows irregular in shape, crowded; longest and ring seta about 105μ. Trilocular pores around 3.5μ in diameter, quinqueloculars around 7μ, internal length of tubular ducts about the same, these with a short, cylindrical, external collar and a considerably longer membranous, somewhat tapering extension, together approximating a little more than half the internal length of the duct. The few scattered dorsal setae with an observed length range of 9–16μ, the longer ventral setae ranging up to 43μ.

This redescription is based on mounted examples of the species, collected by Dr. Joseph Carmin at Tel-Aviv, Palestine, April 12, 1927, prior to the date of publication of the original description of the species. Examiners of both this and the original description will find some discrepancies between the two, notably in the measurements of the antennal segments; all such divergences have been rechecked on the material studied, and statements here presented are believed accurate for this material.

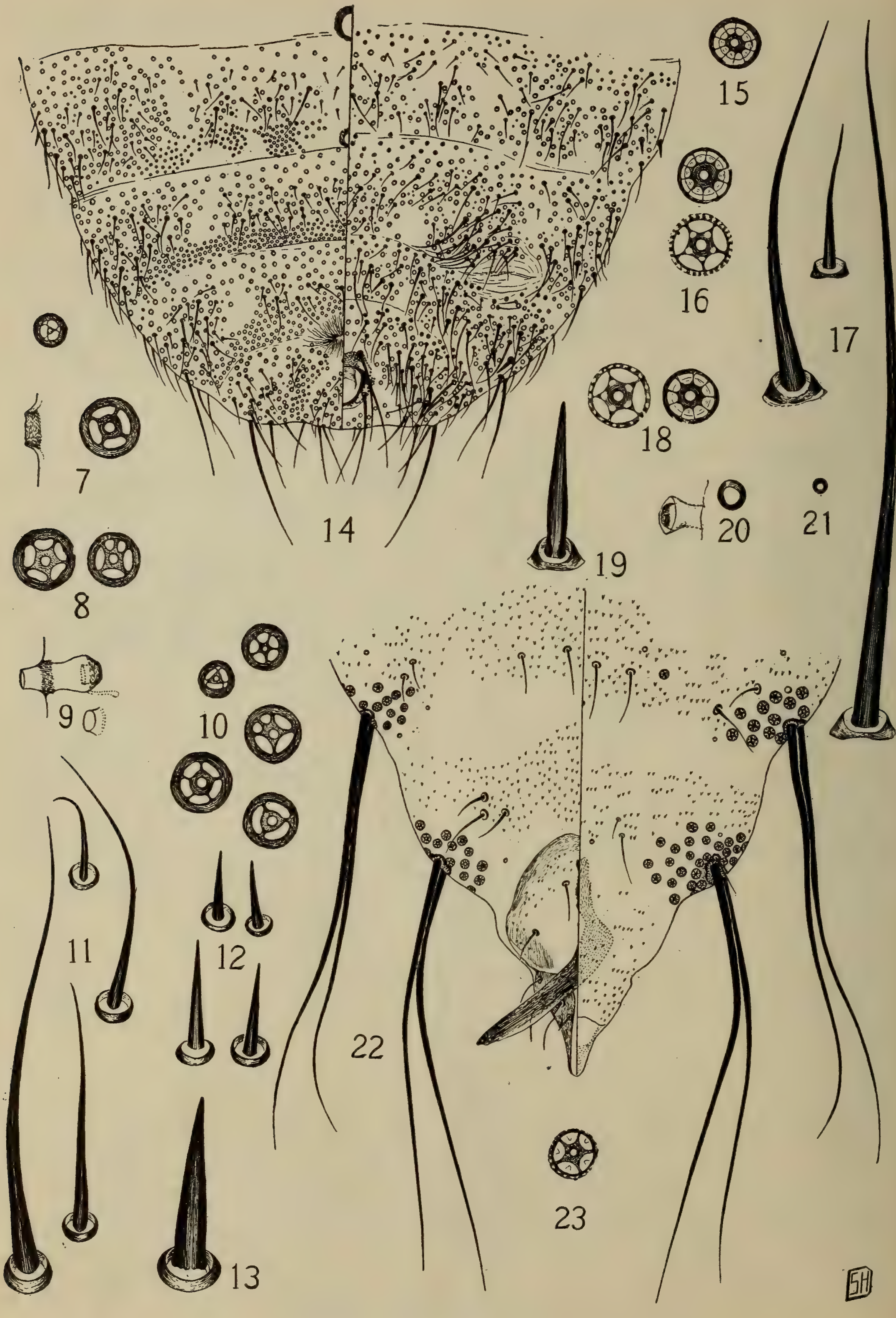
FIGS. 1–5, 7–13.—*Asphodelococcus asphodeli*, adult female: 1, Apex of abdomen, dorsal and ventral, ×115; 2, posterior spiracle with associated pores, ×460; 3, posterior leg, ×230; 4, body, optical section, ×50; 5, antenna, ×230; 7, disk pores in spiracular area, ×1,500; 8, ventral disk pores, ×1,500; 9, tubular duct, ×1,500; 10, dorsal disk pores, ×1,500; 11, ventral setae, showing size variation, ×1,500; 12, dorsal setae, ×1,500; 13, single cerarian spine, ×1,500.

FIGS. 6, 14–21.—*Annulicoccus flagrans*, adult female: 6, Body, optical section, ×50; 14, apex of abdomen, dorsal and ventral, ×115; 15, multilocular disk pore from spiracular area, ×1,500; 16, ventral multilocular and quinquelocular disk pores, ×1,500; 17, body setae, ×1,500; 18, dorsal multilocular and quinquelocular disk pores, ×1,500; 19, cerarian spine, ×1,500; 20, tubular duct, ×1,500; 21, minute simple pore, ×1,500.

FIGS. 22, 23.—*Heterococcus graminicola*, adult male: 22, Apex of abdomen, dorsal and ventral, ×650; 23, disk pore from cerarius of same, ×1,500.



FIGS. 1–6.—(See opposite page for explanation.)



FIGS. 7–23.—(See p. 42 for explanation.)

Genus **Heterococcus** Ferris

Adult female.—Occurring on Gramineae, beneath leaf sheaths, accompanied by more or less white secretion and thinly coated with white powder. Size medium (length 1.5–3 mm), varying strikingly according to maturity of the individual; elongate elliptical to almost parallel-sided, length usually more than twice width. Membranous throughout. Antennae characteristically 9-segmented, the joint between eighth and ninth rigid and often incomplete or lacking; one slender sensory seta on seventh, one on eighth, three on ninth. Eyes circular in outline, approaching hemispherical, each on a small asymmetrical base. Legs normal, a little thickened, no pores on hind coxae, but tiny ones scattered on hind femora and tibiae; claw denticle developed; tarsal digitules slender, acute, not exceeding claw apex, claw digitules slender, slightly knobbed apically, definitely exceeding claw apex. Beak short conical, incompletely 2-segmented. Both pairs of dorsal ostioles present, the lips more or less ornamented with quinquelocular pores and small setae. Definitely recognizable cerarian development at most restricted to the posterior two to four pairs, and the cerarii, even here, not sharply defined, the association of the two spines, quinquelocular pores, and spinelike setae loose and sometimes even indistinct; existence in some species of additional cerarii on anterior abdominal segments and especially on head above eyes more or less suggested but not clearly evident. Anal lobes at most rounded bulges, apical seta definitely developed on each, no ventral thickening. Anal ring of normal pseudococcine type, with six setae, the longest a little shorter than apical seta, and inner and outer rows of pores on each half. Several pore types developed among included species though not all present on each, these including quinquelocular disk, large multilocular disk, tiny clear circular disk, and slender tubular duct. Dorsal body setae small, inconspicuous, varying from slender to almost spinelike; ventral setae slender, averaging much longer, all varying much in size. No ventral cicatrix.

Type of genus.—*Heterococcus arenae* Ferris (4, p. 65).

Although no attempt is made at this time to provide generic descriptions for stages other than the adult female, since these are known from only a single species, the descriptions of the first-stage larva and adult male that are presented for the new species described later from timothy and other hosts should supply

KEY TO SPECIES OF HETEROCOCCUS

a. Multilocular disk pores wanting; cerarii not developed, cerarian spines represented only by slender setae . . . . *biporus* (Goux)

aa. Multilocular disk pores present; at least the apical cerarii developed and usually with evidence of others.

- *b.* Posterior cerarian spines tiny, perhaps one-sixth length of longest of 4 or 5 slender accessory setae associated in each cerarius . . . . *nudus* (Green)
- *bb.* Posterior cerarian spines much larger, at least half length of longest of associated accessory setae.
  - *c.* Cerarian spines and dorsal derm setae slender (see figures), tapering, at most only very faintly lanceolate; multilocular disk pores relatively few, restricted to vulvar area of ventral surface. *arenae* Ferris
  - *cc.* Cerarian spines and dorsal derm setae with obviously stouter proportions, definitely slender spinelike, often fairly distinctly lanceolate; multilocular disk pores much more numerous, present all along body margin and on both surfaces of the abdomen.
    - *d.* Multilocular disk pores more numerous in midabdominal area, dorsally fourth to seventh segments inclusive each with two rows, one complete and one interrupted medially, ventrally with a broken transverse row on third segment, an entire row on fourth, a band three pores wide on fifth, and numerous pores across sixth and seventh [*tritici* Kiritshenko of Borkhsenius] . . . . *borkhsenii*, n. sp.
    - *dd.* Multilocular disk pores, while variable, fewer in midabdominal area, thus, dorsally fourth to seventh segments inclusive each with a single, often somewhat irregular and often incomplete row of pores, ventrally one or two pores on third, several on fourth in a medially interrupted single row, around 20 on fifth in a more narrowly interrupted single row, a continuous band two or three pores wide on sixth, a similar band on seventh, and numerous pores on eighth.
      - *e.* Anal lobe apical and anal ring setae normal, slender, long-tapering, lobe seta around 150μ, longest anal ring seta around 96μ . . . . *graminicola*, n. sp.
      - *ee.* Anal lobe apical and anal ring setae heavy, short, often bifurcate apically, lobe seta 68μ or less, anal ring setae less than 50μ . . . . *occidentalis*, n. sp.

reasonably satisfactory evidence as to the structural characteristics to be expected for these stages in all the included species.

Thus far, five species have been described in or have been transferred to this genus. One of these, *painei* Laing, is made the type of a new genus in this paper. The remainder, together with two apparently undescribed species, are discussed below. All these have been reported from grasses (Gramineae) only.

Goux (8, p. 253), in connection with his description of the new species *biporus*, reduces *Heterococcus* Ferris to the status of a subgenus of *Phenacoccus* Cockerell, but from the present and other studies of mealybug classification it appears that the basic framework of a classification in the group is so poorly developed that there is little assurance that such a subordinate relationship presents a true picture. Accordingly *Heterococcus* Ferris is re-accepted in its original standing as a genus.

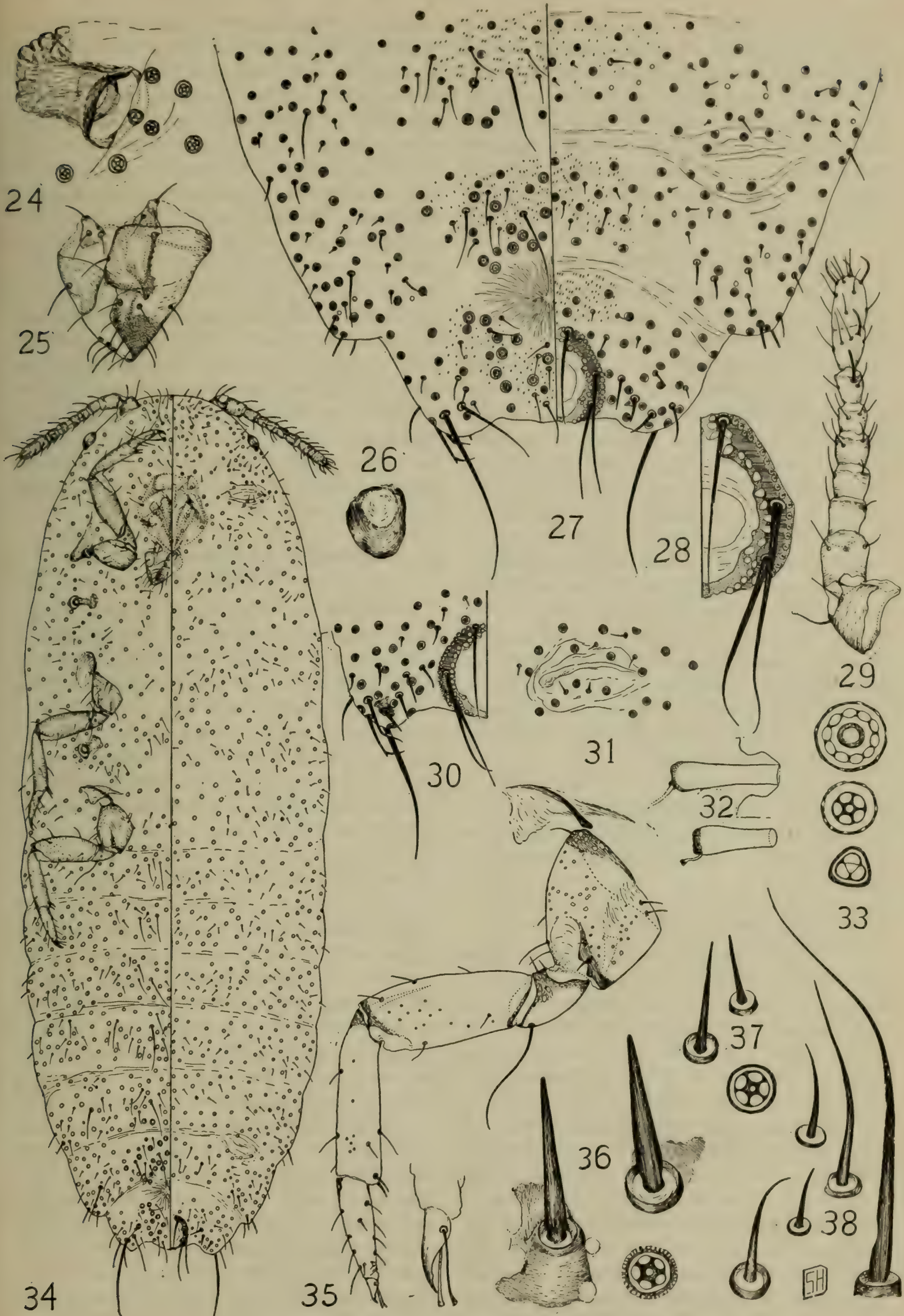
The foregoing key is offered for the separation of the species here included in the genus. No specimens of any of the three European species have been available for examination.

Heterococcus arenae Ferris

Figs. 24–38

Adult female.—Elongate, sides nearly parallel, length 1.6 mm, width 0.55 mm, rounded tapering at anterior end, tapering posteriorly past the penultimate segment, then sharply constricted to the protruding anal segment. Membranous throughout. Antennae normally 9-segmented, maximum longitudinal dimensions of the segments in microns as follows: I, 32–36; II, 40; III, 28–32; IV, 20–22; V, 20; VI, 18–20; VII, 24; VIII, 24–26; IX, 35–38; last two segments incompletely separated in one antenna, combined length 60; sensory setae slender, curved, about 20μ long. Eye small, rounded, set on a comparatively large base, eye diameter about 16μ, base about 33μ. Posterior leg maximum longitudinal dimensions in microns: Trochanter, 60; femur, 120; tibia, 116; tarsus, 68; claw, 20; tarsal digitules, 20; claw digitules, 18–20; claw denticle sometimes obscure; pores on leg parts somewhat uncertain from specimen available, presented in figure as believed to occur. Beak somewhat distorted, apparent dimensions: Length 60μ, width 72μ. Bar of spiracle rather broadly sclerotized, a few scattered pores adjacent to opening. Lips of dorsal ostioles each with two to four quinqueloculars and posterior lip of anterior ostiole with two to three small setae in addition. Each apical cerarius recognizable as a combination of two slender spines about 18μ long, with a quinquelocular pore between them, and with a tiny, irregular, sclerotized area at base of one or more spines, and of a loose group of six to nine additional quinqueloculars and four to five stiff setae, hardly differentiated from the spines and 9–38μ long; the penultimate cerarian association is recognizable as two slender, well-separated spines, each being about 18μ long with a slightly closer association of the quinqueloculars around them; spines of other anterior cerarii probably present, but not clearly distinguishable through size, shape, or pore association. Anal lobes somewhat developed, rounded (the specimen probably recently molted), apical seta around 112μ long, subapical ventral 35–56μ; no ventral thickening. Anal ring with longest setae about 84μ. Body with numerous quinquelocular pores with average diameter about 5μ, but varying somewhat, these approximately uniformly distributed both dorsally and ventrally, except on the intersegmental lines; a few multiloculars, each usually with 10 loculi and average diameter about 6.6μ, on the underside of the abdomen, as follows in specimen examined: 16 behind vulvar opening, 17 in a loose cluster just anterior to vulvar opening, 4 on the next segment anterior; with a few slender, delicate tubular ducts about 10–11μ long, and somewhat varying in diameter, distributed over the body on both surfaces, some, at least, with opening on a protruding cone. Body setae small and inconspicuous dorsally, stiff but not spinelike, lengths from 4–12μ in middorsal area; ventrally much larger and more slender, lengths from 7–55μ in midventral area.

Figs. 24–38.—*Heterococcus arenae*, adult female: 24, Posterior spiracle, ×460; 25, beak, ×330; 26, eye and tubercle, ×370; 27, apex of abdomen, dorsal and ventral, ×230; 28, anal ring, detail of right half, ×460; 29, antenna, ×230; 30, dorsal aspect of left anal lobe area, ×230; 31, anterior dorsal ostiole, ×230; 32, tubular ducts, one with protruding opening, ×1,500; 33, ventral disk pores, multilocular, normal quinquelocular and abnormal quinquelocular, ×1,500; 34, body, dorsal and ventral, showing pore distribution, ×87.5; 35, posterior leg, ×230, with detail of claw, ×650; 36, detail of cerarian spines, ×1,500; 37, dorsal setae and disk pore, ×1,500; 38, ventral body setae, ×1,500.



FIGS. 24–38.—(See opposite page for explanation.)

This species has been redescribed from a single adult female, evidently recently molted, from the type material labeled as collected from *Poa douglasii* on dunes near Pacific Grove, Calif., December 1, 1917, by G. F. Ferris. In addition to this record, Ferris again collected the species, on an undetermined perennial grass, in Inyo County, Calif., between Big Pine and Deep Springs (5, p. 22).

Heterococcus biporus (Goux)

Judged from Goux's description (8, p. 253), this species differs more widely from the characteristic generic condition than does any other included, since it lacks the multilocular disk pores that appear in all the others, the tubular ducts are described as restricted to the ventral surface, and cerarii are reported to be undeveloped, though possibly represented by a pair of long setae on each margin of each of the last two abdominal segments. In his discussion of its relationships the author suggests that it would be desirable to erect a new subgenus of *Phenacoccus* for his species if it were established that the type of Ferris's genus possessed multilocular disk pores. However, from this study of available specimens and descriptions it has seemed best to retain the species in *Heterococcus*, although possibly a different conclusion might have been reached if actual specimens of *biporus* had been studied.

The insect was collected in July 1934 at Tamaris, in the Var Department of France, on *Brachypodium pinnatum*, and there appears to have been no subsequent published record of its rediscovery.

Heterococcus borkhsenii, n. sp.

In 1932 Kiritshenko (14, p. 135) (as Alexis Kiricenko) described the species *Trionymus tritici* from the vicinity of Odessa, U.S.S.R., reporting among other descriptive items body dimensions of 8–9 mm by 3 mm, and the color as pale pink. Later, in 1937, Borkhsenius (2, p. 55), in his tables for the identification of coccids (Coccidae) injurious to cultivated plants and forests in the U.S.S.R., transferred this species to the genus *Heterococcus* and presented a short description and figure for it. On the basis of a noncritical translation of this portion of his paper, which appeared only in Russian, the conclusion appears unavoidable that the specimens which he discusses represent a different species from that described by Kiritshenko. As partial evidence it may be noted that the Borkhsenius specimens have reported dimensions of 2 mm by 1 mm, instead of 8–9 mm by 3 mm, and that the body color is yellowish, not pinkish. Discrepancies in other parts of the descriptions, though less striking, are likewise evident. So far as the literature has been examined no other name seems applicable to the material reported by Borkhsenius and it is therefore here called *borkhsenii*, n. sp., on the basis of his description and figure (2, p. 55). This insect evidently is extremely closely related to the first of the new species described below, and, indeed, it has been difficult to find in Borkhsenius's brief description a positive basis for the separation of the two, yet without some tangible evidence of actual interchange, or, at least, opportunity for this, it does not seem desirable to assume that our American specimens are identical with the Russian species which Borkhsenius discussed.

Heterococcus graminicola, n. sp.

Figs. 22, 23, 39–49, 51–61

Adult female.—Developing between the leaf sheaths and stems of the host, producing some white waxy secretion, and lightly coated with white secretion. Color a pale yellow. Body, as mounted, at least twice as wide as long, varying considerably in size, from a minimum of 1.41 mm by 0.53 mm in recently molted adults to an observed maximum of 3.25 mm long by 1.6 mm wide in fully distended individuals. Maximum dimensions in microns of segments of one, apparently average, antenna as follows: I, 36; II, 40; III, 32; IV, 21; V, 25; VI, 22; VII, 30; VIII, 37; IX, 44; however, obviously with much variation in the lengths of all segments; the sensory setae on apical segments slender, curved, showing an observed length range of 28–44μ; each intermediate antennal segment with a minimum of four to five setae. Eye base about 36μ long, 24μ wide, and, with eye itself, perhaps 12μ high, but variable. Posterior leg with maximum dimensions in microns of parts measured: Trochanter, 73; femur, 170; tibia, 163; tarsus, 85; claw, 20; tarsal digitules, 24; claw digitules, 26; claw denticle usually quite distinct; as with the antennae, considerable variation in the dimensions of the parts of the posterior leg apparent in different individuals; a pattern of scattered, tiny, clear pores over the upper surface of femur and tibia, but none on coxa. Beak around 73μ long by 76μ wide, but

dimensions varying somewhat. Dorsal ostioles inconspicuous, especially on distended specimens, usually three to four quinqueloculars on each lip, and a single short, stiff seta on the posterior lip of each cephalic ostiole. The posterior three pairs of cerarii fairly plainly developed, and the fourth and fifth from the caudal apex often suggested by a pair of recognizable cerarian spines, the two spines in each pair usually distinctly separated, but appreciable variation occurring in the extent of development of all these cerarii; an average anal lobe cerarius including two faintly lanceolate spines around 17–22μ long, about 15–18 loosely grouped quinquelocular pores, and 3–6 stiff, short setae, differentiated from spines chiefly by smaller size; basic organization of the other evident cerarii including two spines and a few quinqueloculars, with the small setae really outside this association; a recognizable supraocular cerarius including, usually, three small spines and two or more quinqueloculars; organization of all cerarii, except anal lobe pair, tending to become obscured with body distension at maturity. Anal lobes suggested by rounded bulges in just molted adults, not evident in fully distended individuals; apical seta with maximum observed length 157μ, ventral subapical 60μ, and several smaller ventral setae from 16μ to 32μ long. Longest observed anal ring seta 100μ. Derm pores and ducts numerous, quinqueloculars widely and fairly uniformly distributed over both surfaces except for intersegmental clear bands and areas occupied by multiloculars, diameter around 4μ; multiloculars with diameter around 6–7μ and 10–12 loculi distributed in groups or rows dorsally, ventrally, and along margin, these groups conspicuous only in recently emerged adults, more or less obscured in fully distended individuals; numbers and groupings varying much from individual to individual, approximately as follows in one examined fully: Along margin, each side a cephalic group of 25 before antennal base, an ocular group of 5 or 6, a postocular of 17, about 5 scattered, a group opposite anterior coxa of 11, 2 scattered, a group opposite midcoxa of 8, 4 scattered, a group opposite posterior coxa of 7, first abdominal 6, second abdominal 3, third abdominal 12, fourth abdominal 15, fifth abdominal 20, sixth abdominal 36, seventh abdominal 46, last two practically continuous with ventral transverse rows of similar pores; dorsally with a scattered transverse row of 10 pores on abdominal segment III, of 17 on abdominal segment IV, of 20 on V, of 15 on VI, of 5 on VII; ventrally with 1 on III, 9 on IV, interrupted medially, 31 on V, 44 on VI, about 70 on VII, and about 65 on VIII; slender tubular ducts numerous ventrally, in one individual around 16 on underside of each anal lobe, around 66 across abdominal segment VII (prevulvar), around 98 across the next preceding (VI), around 71 on the next (V), and successively fewer on the anterior abdominal segments; apparently wholly absent on head and thoracic segments, much fewer dorsally on abdominal segments and likewise apparently absent on head and thorax, approximate length 9–10μ, diameter at opening 1.7μ, at inner end 2.1μ; a very few tiny, flat, cylindrical pores without apparent internal structure, with diameter about 1.6μ visible both dorsally and ventrally. Dorsal setae not numerous, small and inconspicuous, stiff, almost spinelike, observed lengths varying from 3–6μ in the middorsal area, to 10μ toward margins; ventral setae slender, much longer, 12–36μ in midventral area and up to 44μ toward apex of abdomen.

Larva.—Elongate ovoid, length 0.52 mm, width 0.2 mm. Body membranous throughout, except a small, slender thickening from base of ventral subapical seta of each anal lobe. Antennae not unusual, dimensions of one in microns; I, 20; II, 20; III, 16; IV, 10; V, 12; VI, 56; three long sensory setae at apex of terminal segment, one on preapical. Eyes distinct, somewhat bulging, anterior margin of small, basal collar much wider than posterior. Legs not unusual, maximum lengths, in microns of parts of a posterior one: Trochanter, 32; femur, 64; tibia, 52; tarsus, 56; claw, 18; acute tarsal digitules, 24, faintly knobbed, slightly dissimilar, claw digitules, 18; claw denticle weakly developed but usually evident, sometimes obscure or wanting. Beak short conical, rounded apically, 40μ long by 44μ wide, incompletely 2-segmented. Spiracles small circles with slender tapering bar, a single quinquelocular pore outside each. Dorsal ostioles present, but obscure, especially the anterior. No complete cerarii developed, but a pair of enlarged spines on each side of anal ring, and additional pairs, reduced in size and the two spines more or less obviously associated, along the body margin to the cephalic apex, a total of 18 pairs evident and possibly homologous with the true cerarian

spines of species having these fully developed; individual quinquelocular pores more or less obviously associated with each spine pair. Anal lobes not developed, only a slight bulge on each side of anal ring; apical seta 76μ, ventral subapical 28μ, a small, irregular thickening about twice as long as wide extending forward from this. Anal ring normal, with 6 setae with maximum length around 40μ. Only quinquelocular-type pores present, appearing as if in longitudinal rows on abdomen, middorsal about 2.4μ in diameter, laterals up to 4μ. Setae tiny, almost spinelike, about 4μ in middorsal area, somewhat larger laterally and posteriorly, with anal lobe cerarian spines about 8μ; ventral setae slender, maximum about 20μ.

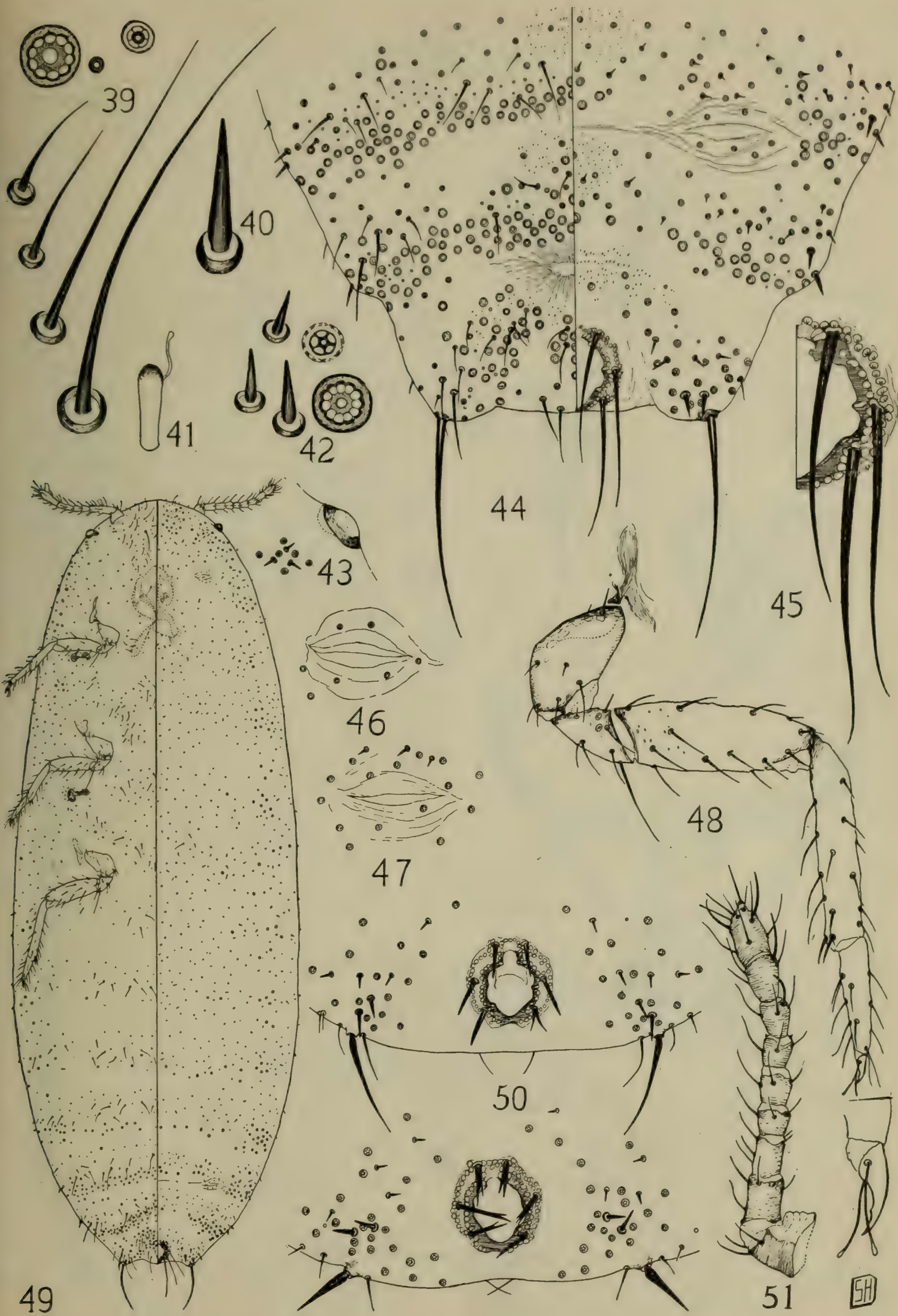
Adult male.—Fully developed, winged, thorax strongly sclerotized; body length (of one individual) 1 mm, width (through thorax) 0.26 mm. Head rounded from above, ventral surface more strongly sclerotized, this sclerotization continued dorsally on each side into an elongate triangular area enclosing the two upper eyes. Front of head, around and between antennae, and middorsal area between eyes somewhat less strongly sclerotized, bearing an irregularly elongate cluster of 10–12 tiny, simple pores above each antennal insertion, an irregular row of around 10 curved setae, each about 13μ, on each side between upper eye and mid-line, and perhaps 15 longer curved setae, up to 22μ, between antennal insertion and lower eyes; posterior portion of head membranous, transparent, bearing a cluster of 4–5 small setae (around 14μ) dorsally on each side behind sclerotized area enclosing upper eye. Prothorax strongly transverse, anterior margin, and a triangular, posteriorly directed extension of this on each side, an irregular plate at posterior margin behind the anterior marginal areas, and coxal attachment piece all sclerotized; remainder of prothorax membranous; quinquelocular disk pores and small setae dorsally as in figure, a pair of quinqueloculars and two tiny simple pores between coxae, and a pair of setae with a tiny simple pore behind each coxa ventrally. Mesothorax and metathorax definitely sclerotized, shape and dorsal setae as shown in figure, length 280μ, width 260μ; wing shape and venation as in figure, surface thickly clothed with tiny hairs, with larger ones forming a marginal fringe, length 800μ; halteres about 60μ long, elongate, somewhat enlarged about middle but with anterior margin irregular and incised at one or more points; a single apical seta, strongly recurved, at apex, length to apex of curve 48μ. Legs moderately slender, each trochanter with three sensory pores on each face, each tarsus plainly 2-segmented, the basal ringlike, claw nearly straight, with small denticle on inner face about one-third of length from tip; leg setae stiff, but tapering to very slender apices, a pair of definitely enlarged, spinelike setae at apex of each tibia; lengths of parts of a hind leg in microns: Trochanter, 48; femur, 120; tibia, 162; tarsus, 84; claw, 27; slender tarsal digitules, 32; short, acute claw digitules, 5. Abdomen membranous throughout, except for apex and for one complete transverse sclerotized band just behind scutellum and one to three additional, medially interrupted and obscure, on the one to three segments immediately following that bearing the complete band; arrangement of dorsal quinquelocular and tiny disk pores and setae (about 22μ) about as shown in figures; ventrally with a transverse row of from four to eight setae (about 16μ) across the midline of the segments, and with a marginal cluster, characteristically of three to four setae, a single quinquelocular and a single tiny disk at each margin of the segments anterior to the cerarii; two pairs of cerarii, each cerarius with two long (156μ), slender setae, a close cluster of quinquelocular pores (anterior around 24, posterior around 46), two to four tiny disk pores, and usually just outside the pore cluster

FIGS. 39–49, 51, 54.—*Heterococcus graminicola*, adult female: 39, Ventral setae and disk pores, ×1,500; 40, cerarian spine, ×1,500; 41, tubular duct, ×1,500; 42, dorsal setae and disk pores, ×1,500; 43, eye and adjacent supraocular cerarius, ×370; 44, apex of abdomen, dorsal and ventral, ×230; 45, anal ring, right half, ×460; 46, anterior and 47, posterior dorsal ostioles, ×230; 48, posterior leg, ×230, with detail of claw, ×650; 49, body, dorsal and ventral, with distribution of pores, ×50; 51, antenna, ×230; 54, beak, ×330.

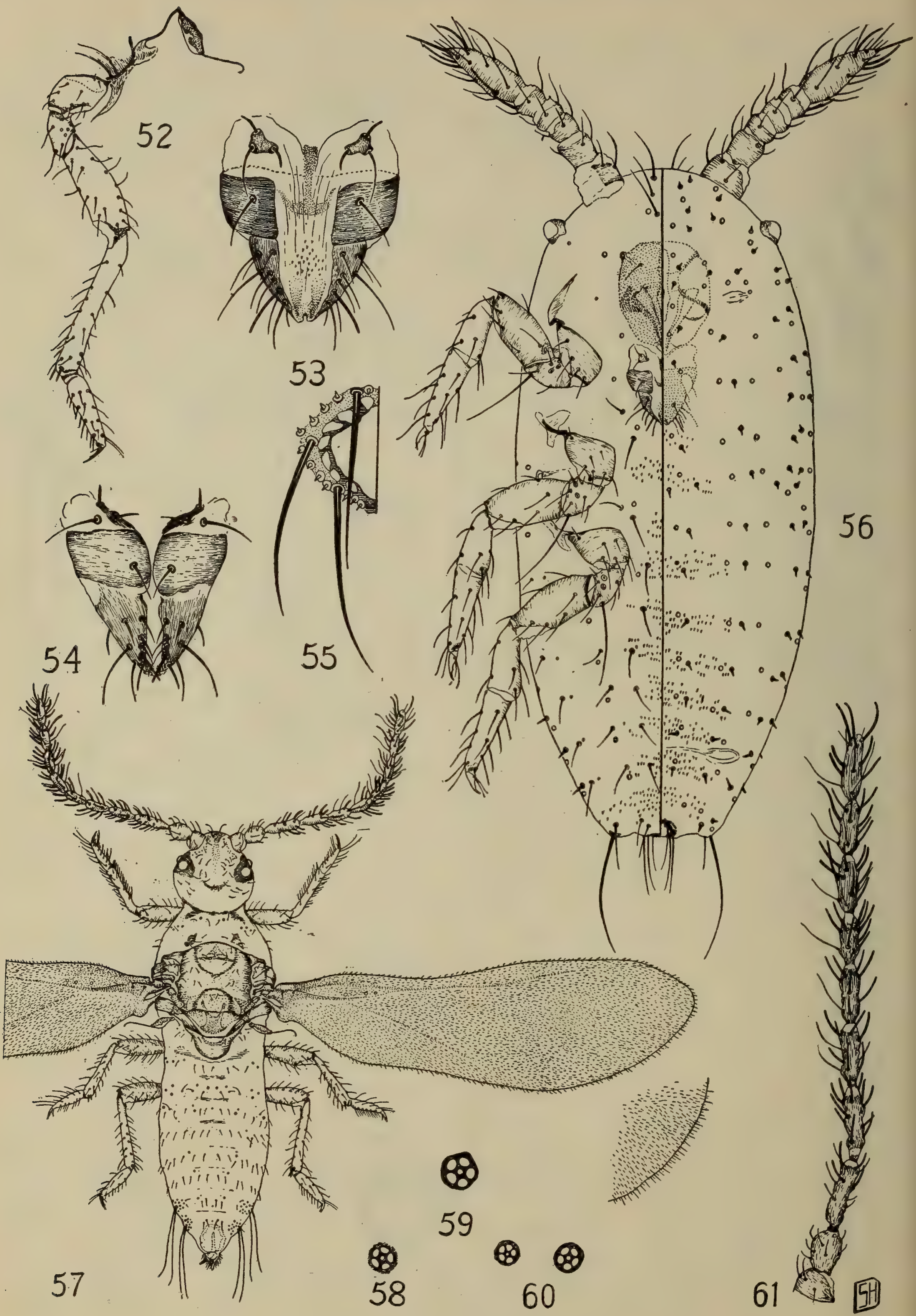
FIG. 50.—*Heterococcus occidentalis*, adult female, apices of abdomen, dorsal of two individuals, ×230.

FIGS. 52, 57–61.—*Heterococcus graminicola*, adult male: 52, Posterior leg, attachment plate and halter, ×165; 57, body, dorsal, ×87.5, with detail of wing margin, ×165; 58, ventral disk pore, ×1,500; 59, marginal disk pore, ×1,500; 60, dorsal disk pores, ×1,500; 61, antenna, ×165.

FIGS. 53, 55, 56.—*Heterococcus graminicola*, first stage larva: 53, Beak, ×650; 55, anal ring, left half, ×825; 56, body, dorsal and ventral, ×230.



Figs. 39–51.—(See opposite page for explanation.)



Figs. 52–61.—(See p. 50 for explanation.)

two to five slender setae; genital capsule at apex of abdomen about 100μ long, its protruding tip with expanded conical base about 36μ; penis proper about 60μ; penis directed diagonally downward, nearly straight except for slightly curved base.

This insect has been described from a number of specimens, mounted and unmounted, including material on timothy (*Phleum pratense*) from Wooster, Ohio, June, July, and August 1944, the first and last lots forwarded for study by J. S. Houser, the July lot collected by Dr. F. W. Poos (holotype and paratypes); from foxtail (*Setaria viridis*) from Washington, D. C. (Mount Pleasant section), August 13 and 20 and September 3, 1944, collected by Harold Morrison (paratypes and male allotype); in grass sheaths, from Fort Lee, N. J., May 24, 1938, collected by George Rau (paratypes); and on *Poa* sp., Portland, Oreg., May 12, 1944 (No. 16271) collected by George C. Anderson and James Roaf. In addition, specimens on Fescue grass from State College, Pa., October 25, 1941, collected by Keil, although all preadult stages, are considered to be this species, as are adult females on *Festuca rubra* in field, collected at State College, Pa., in 1942 by Keil (received through G. F. Ferris). The types are in the U. S. National, collection of Coccidae.

The relationships of this species have been indicated in the key to species, and in the discussion under *Heterococcus borkhsenii*. The New Jersey specimens examined are very similar to the material from Ohio; the specimens from the District of Columbia seem to average a little lower with respect to numbers of pores on various parts of the body, but no basis has been found thus far for a suspicion that they might be specifically distinct from the Ohio specimens.

Heterococcus nudus (Green)

First described in 1926 (11, p. 172) as a *Phenacoccus*, this species was transferred two years later by its author (12, p. 21) to *Heterococcus*. The only subsequent references of significance that have come to attention are by Goux (6, p. 332; 7, p. 63; 8, p. 256), who found the species in southern France.

Assuming the full accuracy of all details of the original description and figures, we may distinguish the species easily from others included in the genus, as shown in the key.

Green's specimens came from undetermined grasses taken at Camberly, England; Goux's, from *Holcus lanatus* collected at Courzieu, Rhone Department, France.

Heterococcus occidentalis, n. sp.

Fig. 50

Adult female.—Very similar to *graminicola* in size and organization of pores, ducts, and setae but differing sharply in respect to appearance and dimensions of anal ring and anal lobe apical setae, these in all specimens examined much shorter and much stouter in appearance than with *graminicola*. Size as mounted up to 2.93 mm by 1.63 mm; elongate elliptical, broadly rounded at ends. Antennae characteristic, lengths of one in microns: I, 40; II, 44; III, 36; IV, 23; V, 24; VI, 23.6; VII, 28; VIII, 32; IX, 44; sensory seta on VII often curved and twisted, that on VIII about 28μ long, those on IX about 24μ long. Eye with outside dimensions of base around 24μ by 8μ. Legs characteristic, posterior with an obscure pattern of tiny clear pores as in other species, and with maximum lengths of parts of one in microns as follows: Trochanter, 64; femur, 153; tibia, 140; tarsus, 84; claw, 19.5; tarsal digitules, 21; claw digitules, 20; claw denticle present but often inconspicuous. Beak characteristic, length of one 68μ, width 72μ. Spiracles characteristic. Dorsal ostioles quite inconspicuous. Usually only the apical two pairs of cerarii definitely recognizable, spines in anal lobe cerarii about 17μ long, with 10–12 quinqueloculars adjacent, and one to two stiff body setae associated; penultimate cerarii less developed, and cerarian traces on next two anterior segments of abdomen rather obscure. Anal lobes not developed, apical seta short, usually heavy, observed length range from 44μ to a maximum of 68μ, ventral subapical seta likewise stout, about 28μ long, perhaps six additional scattered ventral setae, approximating 16μ in length. Anal ring with setae short, observed maximum 40μ, many between 30μ and 36μ, some of normal shape, but many flattened and split apically, as if composed of two setae fused together for most of their lengths. Quinqueloculars widely distributed, general distribution of multiloculars as in *graminicola*, along margins and dorsally and ventrally in abdominal area; numbers very variable, observed range of total marginal multiloculars 120–225, dorsal and ventral about as in *graminicola*, but variable; small tubulars similar,

but somewhat fewer. Body setae likewise similar, observed range of middorsal 5–10μ, maximum observed midventral 24μ, all somewhat stiffer than with *graminicola*.

This species is based on a few mounted and unmounted specimens collected August 28, 1940, on grass at Yakima, Wash., by F. W. Carlson. These are so very close to *graminicola* that a decision was made to describe them only after long consideration. The extraordinary condition of the anal ring and anal lobe setae surely is due, in part at least, to molting difficulties of some sort at the time of change from preadult to adult, but this would not with certainty account for all the differences that appear in these structures, since the few in the material examined that approximate normal condition are likewise much shorter and stouter than corresponding structures in *graminicola*.

The types are in the U. S. National collection of Coccidae.

Laingiococcus, n. g.

Adult female.—Appearance in life uncertain. Broad elliptical, flattened dorsally and ventrally, posterior apex broadly notched. Size medium, length 2 mm; derm membranous throughout. Antennae 9-segmented, apical segment short, not enlarged, with two sensory setae, preapical with one. Eyes developed. Legs not unusual, claw with distinct denticle, tarsal digitules acute, not attaining claw apex, claw digitules longer, extending well beyond tip of claw, knobbed at apices. Beak described as 1-segmented. Spiracles not unusual. Dorsal ostioles described as absent. No cerarii of any sort developed, at most with evident clusters of large body setae on margins of terminal abdominal segments. Anal lobes broadly rounded protrusions, apical seta not differentiated. Anal ring removed from the body apex, appearing dorsal, presumably with six setae, each half narrow, apparently with a single pore row. With circular quinquelocular pores on both surfaces, and multilocular disk pores on posterior abdominal segments. Body setae numerous, some large, stiff, some small, slender. A single transversely elliptical ventral cicatrix.

Type of genus.—*Heterococcus painei* Laing (15, p. 20).

The preceding description has been based entirely on the description of the genotype (15). Laing's placement of this species in *Heterococcus* has been accepted as the starting point for its reassignment to a related new genus, but it should be noted that the description contains certain discrepancies which, if verified, may prove barriers to the assumed close relationship. Thus the described absence of doral ostioles and of all traces of cerarii, the occurrence of an unsegmented beak (perhaps a question of interpretation of structure), and (from its illustration) the narrow anal ring with only a single pore band all depart widely from the basic pseudococcine structure exhibited by the other genera here discussed.

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ENTOMOLOGY.—*A new genus and twelve new species of Neotropical whiteflies (Homoptera: Aleyrodidae).*[1] Louise M. Russell, Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. Muesebeck.)

This paper treats the pupae of an interesting new genus of Aleyrodidae that is widely distributed in the Antillean Subregion of the Neotropical Region but that is unknown elsewhere. Members of the group appear to be somewhat restricted in their host associations, for each available species is recorded from only one plant genus, and several of those at hand are known from a single species of plant. Such geographical and host limitations doubtless will be somewhat modified by additional collecting, however. Two species described here, from *Malpighia* and *Stigmaphyllon*, respectively, were received for identification. Ten species were collected from herbarial specimens of *Coccoloba* by Marjorie J. Camp, Bureau of Entomology and Plant Quarantine, through the courtesy of the persons in charge of the Arnold Arboretum, the Gray Herbarium, the New York Botanic Garden, and the United States National Herbarium. In the collection data for the species from *Coccoloba* the names of the herbaria are abbreviated; the name of the plant collector is given when known. Type specimens are in the collection of the United States National Museum.

Crenidorsum, n. gen.

The genus *Crenidorsum* is composed of both similar and diverse species, with intergrading forms between the extremes of the group. Little variation has been observed in the characters which separate the species, and the most closely related forms are amply distinct from one another. The genus appears to be most closely allied to three genera established by Quaintance and Baker, *Aleuroplatus*, *Aleurotrachelus*, and *Aleurotulus*, and superficially at least it resembles *Aleuroputeus* and *Laingiella*, both erected by Corbett for Oriental species. *Crenidorsum* can be distinguished from these and other genera by the following combination of characters: A somewhat longitudinal, differentiated line consisting of a row of scallop-shaped thickenings, or a ridge, or a furrow, in inner subdorsum (for terminology see Russell, Proc. Ent. Soc. Washington **45**: [131]–132, 1943) on each half of body; those intersegmental sutures lying between differentiated lines terminating mesad of lines; vasiform orifice subcordate to broadly elliptical, its sides apparently without minute spines and not continued forward to form the bottom of the orifice; operculum nearly or actually filling orifice, not recessed posteriorly; lingula appearing jointed near the center, expanded distally but not transverse, with an apical notch; submedian cephalic setae present; submargin not separated from dorsal disk; without median abdominal disk pores, a complete submarginal or subdorsal row of setae, or a tubercle between caudal setae.

Generic description.—Body somewhat oval, flat to slightly convex dorsally, flat ventrally. Brown or black and heavily sclerotized, or colorless and membranous.

Body margin weekly to strongly dentate. Anterior and posterior marginal setae present. Ridges extending mesad from margin. Submargin not separated from dorsal disk, not deflexed.

A somewhat longitudinal, differentiated line consisting of a row of scallop-shaped thickenings, or a ridge, or a furrow, in inner subdorsal area of cephalothorax and abdomen, on each half of body. A submedian pair of cephalic, eighth abdominal, and caudal setae. Three subdorsal pairs of minute setae on thorax and 1 anteriorly on abdomen. Transverse molting suture extending laterocaudad from its midpoint, curved cephalad slightly mesad of, and

[1] Received November 11, 1944.

continued at least to, differentiated lines; its center approximately three times as far from mesometathoracic suture as from thoracoabdominal one. Intersegmental sutures between differentiated lines terminating mesad of lines; cephalothoracic and promesothoracic sutures curved posteriorly. Median length of cephalic segment greater than that of thorax; pro-, meso-, and metathorax subequal; abdominal segments 1–6 subequal. Pockets rather small, not contiguous. Pairs of submedian depressions arranged as follows: Three on cephalic segment (1 or 2 mesocephalad and 0 or 1 mesad of setae, and 1 posterior to setae near suture), 2 small or 1 large in cephalothoracic suture, 1 on prothorax, 1 in promesothoracic suture, 1 each on meso- and metathorax, 1 adjoining posteriorly thoracoabdominal and each abdominal suture; cephalothoracic and posterior abdominal ones often rather faint. Vasiform orifice subcordate to broadly elliptical, located approximately its length from posterior suture and at least its length from body margin; its sides minutely ridged vertically, apparently without minute spines, slightly converging near base but nearly vertical, not continued forward to form the bottom of the orifice; rim of orifice rather thick. Operculum nearly or actually filling orifice, not recessed; ventrally covered with minute spines, a pair of small setae near center. Lingula somewhat linear near base, narrowed and appearing jointed near the center; gradually expanded distally, but not transverse, with an apical notch; longer than orifice but lying in a curved position and contained in it; a pair of minute lobes bearing a pair of small setae, near base of expanded area; a pair of elongate setae arising ventrally just before apex; covered with minute spines. Caudal furrow broad, shallow. Caudal ridges (ridges laterad of either or both the vasiform orifice and caudal furrow) present.

Tracheal folds defined. Spiracles small, thoracic and anterior abdominal pair nearly as large as posterior pair, the latter slightly posterior to widest part of orifice. Antenna reaching to anterior spiracle; distal eighth narrowed, covered with minute spines, a sensorium at base and a seta at apex. Two minute setae just before disk of each leg, one just before these, and at least one on inner basal area of each middle and posterior leg. One pair of adhesive sacs. Male organ apparently a simple (not bifid) sac.

Genotype, *Crenidorsum tuberculatum*, n. sp.

Key to Species of Crenidorsum

1. Minute spines absent ventrally; submedian cephalothoracic and eighth abdominal setae either about 14μ long and somewhat nail-shaped, or about 6 or 100–125μ long and slender, not stout at base in relation to length (Figs. 5, 18, 20) 2
   Minute spines present ventrally; submedian cephalothoracic and eighth abdominal setae 30–60μ long, somewhat conical, stout at base in relation to length (Figs. 22, 30) . . 9
2. Derm brown or black and heavily sclerotized; a row of large scallop-shaped thickenings in inner subdorsum, terminating on abdominal segment 7; submarginal teeth present; minute setal bases present, located mesad of scallops; submedian cephalothoracic and eighth abdominal setae somewhat nail-shaped (Fig. 5) 3
   Derm colorless and membranous; a row of small scallop-shaped thickenings, or a ridge with scallops suggested, or a furrow without a suggestion of scallops, in inner subdorsum, each terminating before abdominal segment 7; submarginal teeth apparently absent; minute setal bases absent; submedian cephalothoracic and eighth abdominal setae tapered from base to tip (Figs. 18, 20) 7
3. Outer side of ridge over scallops densely sclerotized and tending to be divided into somewhat rectangular, transverse plates with a plate over each scallop, rows of minute, stout spines running lengthwise of each plate (Figs. 10, 11); submedian depressions and intersegmental sutures unusually conspicuous, deep, dotted and bordered with minute irregular areas and minute spines (Fig. 10); marginal teeth about twice as long as wide, about 15 in 100μ; 3 pairs of subdorsal minute setae on cephalic segment. *ornatum*, n. sp.
   Outer side of ridge over scallops, and submedian depressions and intersegmental sutures not as in *ornatum;* marginal teeth not or only slightly longer than wide, no more than 13 in 100μ; 0 or 1 pair of subdorsal minute setae on cephalic segment . . 4
4. Outer disk pores subdorsal in position, the majority approximately three times the width of a marginal tooth from submarginal teeth (Fig. 3); a well-defined median tubercle on each of abdominal segments 2–6 (Fig. 1); 1 pair of outer subdorsal minute setae on cephalic segment. *tuberculatum*, n. sp.
   Outer disk pores submarginal in position, the majority no more than the width of a marginal tooth from submarginal teeth; median tubercles absent, or well-defined only on abdominal segments 2–5; no subdorsal minute setae on cephalic segment 5
5. Two pairs of subdorsal disk pores on posterior segment, 0 just laterocaudad of vasi-

form orifice (Fig. 12); majority of outer disk pores the width of a marginal tooth from submarginal teeth; most marginal teeth slightly longer than wide, approximately 13 in 100μ........*commune*, n. sp.

Three pairs of subdorsal disk pores on posterior segment, 1 pair just laterocaudad of vasiform orifice; majority of outer disk pores at ends of submarginal teeth; most marginal teeth at least as wide as long, approximately 10 in 100μ................6

6. A median tubercle on each of abdominal segments 2–5; ends of body broadly curved, the posterior end as broad as the anterior end and nearly straight in the center; caudal setae as near to body margin as to vasiform orifice............*malpighiae*, n. sp.

No median tubercles on abdomen; ends of body less broadly curved, the posterior end narrower than the anterior end and curved in the center (Fig. 13); caudal setae about one-third nearer to vasiform orifice than to body margin..............*armatae*, n. sp.

7. (2) Differentiated inner subdorsal line consisting mostly of small scallops (Fig. 14); submedian mesothoracic setae present, these and other submedian setae about 6μ long. *leve*, n. sp.

Differentiated inner subdorsal line either a ridge or a furrow, without distinct scallops; submedian mesothoracic setae absent, or these and other submedian setae at least 100μ long............................8

8. Differentiated inner subdorsal line a low distinct ridge sclerotized on its outer side (Fig. 17); submedian setae approximately 100–125μ long, mesothoracic pair present (Fig. 16); 0 submedian disk pores on first abdominal segment, 1 inner subdorsal pair on meso- and metathorax (Fig. 16). *differens*, n. sp.

Differentiated inner subdorsal line a narrow furrow sclerotized on each side (Fig. 19); submedian setae approximately 6μ long, mesothoracic pair absent (Fig. 21); 1 pair of submedian disk pores on first abdominal segment, 2 inner subdorsal pairs on meso- and metathorax (Fig. 21). *marginale*, n. sp.

9. (1) Derm membranous, colorless; submedian meso- and metathoracic setae absent, cephalic ones about 40μ long, and 8μ in diameter at the base, eighth abdominal ones about 30μ long, and 6μ in diameter at the base; rows of scallops terminating on abdominal segment 6 (Fig. 29). *diaphanum*, n. sp.

Derm sclerotized, brown or black; submedian meso- and metathoracic setae present, these, cephalic, and eighth abdominal ones about 60μ long, and 14–20μ in diameter at the base; rows of scallops terminating on abdominal segment 5.................10

10. Ridges extending inward from submarginal furrow of ventral surface except in tracheal folds and beside abdominal tracheal fold; a band of minute spines reaching from ridges to submedian area, also present across tracheal folds (Fig. 26); a tongue-shaped projection extending inward from collar around each submedian cephalothoracic seta (Fig. 28); 20–26 scallops in each row.................*stigmaphylli*, n. sp.

Ridges extending inward from submarginal furrow of ventral surface much less numerous than in *stigmaphylli*, or absent; minute spines much less numerous or arranged differently than in *stigmaphylli;* no tongue-shaped projection extending inward from collar around submedian cephalothoracic seta; 26–36 scallops in each row.......11

11. Ventral surface with ridges extending mesad from submarginal furrow on cephalic segment and on abdominal segments 2–4; minute spines in a band starting near median line anteriorly, and terminating before ventral abdominal setae, mesad of ridges (Fig. 25); a rather deep invagination in anterior margin of vasiform orifice (Fig. 24); caudal setae considerably farther apart than eighth abdominal ones...........*debordae*, n. sp.

Ventral surface without ridges; minute spines along tracheal tract from anterior edge of thoracic tracheal folds to anterior abdominal spiracles (Fig. 23); a relatively shallow invagination in anterior margin of vasiform orifice; caudal setae as far apart as eighth abdominal ones.........*magnisetae*, n. sp.

Crenidorsum tuberculatum, n. sp.

Figs. 1–5

White, cottony, waxy material extending outward from submargin in contiguous strands about one-third as long as width of body; similar strands also extending from inner subdorsum to body margin; a few flecks of white, waxy material scattered mesad of strands. A layer of transparent, colorless wax present ventrally, rather thick at margin, thin elsewhere.

Body broadly oval, ends broadly curved, posterior end nearly straight in center; slightly narrowed on pro- and mesothorax, widest across metathorax and first abdominal segment; 0.75–1.10 mm long and 0.60–0.85 wide. Brown to black, heavily sclerotized.

Marginal teeth strong, close-set, their sides converging slightly and their apices broadly curved, slightly longer than wide, 3 or 4 at each tracheal pore area often slightly smaller than others, slightly variable in width, approximately 10 in 100μ. Submarginal teeth located slightly mesad of marginal ones, weak, light colored, netlike in appearance. Each marginal seta about 28μ long.

Ridges extending from margin to inner subdorsum, as wide as a marginal tooth in submargin, at least twice that width in subdorsum. An inner subdorsal row of 24–30 strong, heavily sclerotized, scallop-shaped thickenings; 1 or 2 scallops smaller and mesad of others (sometimes poorly defined) on cephalic segment, rows slightly and evenly curved from cephalothoracic suture, terminating on abdominal segment 7; scallops nearly contiguous, the curved portion extending into the body cavity, the outer ends in derm and forming the basal part of the outer side of a rather sharp ridge extending over scallops; scallops as long as height of ridge; outer side of ridge more heavily sclerotized than subdorsum, a membranous line at top of ridge. A subcircular or transverse, smooth, median tubercle near posterior edge of each of abdominal segments 2–6. A submedian pair of meso- and metathoracic setae present; these, cephalic, and eighth abdominal ones somewhat nail-shaped, about 14μ long; metathoracic ones located close to anterior edge of transverse molting suture, eighth abdominal pair cephalolaterad of vasiform orifice, midway between orifice and posterior suture; caudal setae tapered from base, about 6μ long, located on outer side or on top of caudal ridges, slightly nearer to body margin than to orifice, practically as far apart as eighth abdominal ones. The four pairs of subdorsal minute setae in central subdorsum, an additional pair in outer subdorsum on cephalic segment. Two inner subdorsal (mesad of scallops) pairs of minute setal bases on prothorax and 1 pair usually on each of abdominal segments 3–5. Inner margin of disk pores not circular, with 2–5 points, larger than associated porettes; pores arranged in a row about three times the width of a marginal tooth from submarginal teeth, about one-seventh as numerous as teeth; other pores in a row distad of and about one-half as numerous as scallops; an occasional pair between the rows and 3 or 4 central subdorsal pairs on cephalic segment; mesad of rows of scallops and an imaginary curved line extending from their ends to median line of body, pairs of pores arranged as follows: Cephalic segment, 1 submedian anteriorly and 1 near cephalothoracic suture, and 1 subdorsal; prothorax, 1 submedian and 2 subdorsal; meso- and metathorax, each 2 submedian and 1 subdorsal; first abdominal segment, 0; second, 1 submedian; third through fifth, and seventh, each 1 submedian and 1 subdorsal; sixth, 1 subdorsal and rarely 1 or 2 submedian pores; eighth, 1 subdorsal laterocaudad of eighth abdominal seta, 1 slightly posterior to widest part of orifice, and 1 just laterocaudad of orifice. Transverse molting suture terminating just outside scallops, its ends nearly opposite its center; a little transverse sculpturing along median molting suture; abdominal sutures 1–6 terminating just outside submedian area, their ends nearly straight; abdominal segment 7 one-half to two-thirds as long as segment 6; intersegmental sutures and submedian depressions moderately defined, the latter more distinct on abdomen than on cephalothorax. Vasiform orifice subcordate, the outer edge of its rim not, or barely defined anteriorly, but the inner edge of its rim defined around anterior end of orifice, measuring 48–62μ long and wide (including lip between rim and margin anteriorly and rim elsewhere, the former 4–6μ long and the latter 4–6μ thick); orifice slightly elevated, a depressed line along its sides, located about one and one-third times its length from body margin. Operculum filling orifice, with 2 longitudinal depressed lines and 1 or 2 transverse ones. Caudal ridges weak, extending from opposite orifice to caudal setae.

Ventrally a membranous furrow just within margin. Minute, slender, spine-shaped markings in abdominal tracheal fold. Ventral abdominal setae 24μ long.

Type.—U.S.N.M. 56965. Between Guayanilla and Tallaboa, Puerto Rico, from *Coccoloba.*

Described from 14 specimens collected from *Coccoloba obtusifolia* Jacq. in Puerto Rico; between Guayanilla and Tallaboa, plant collector

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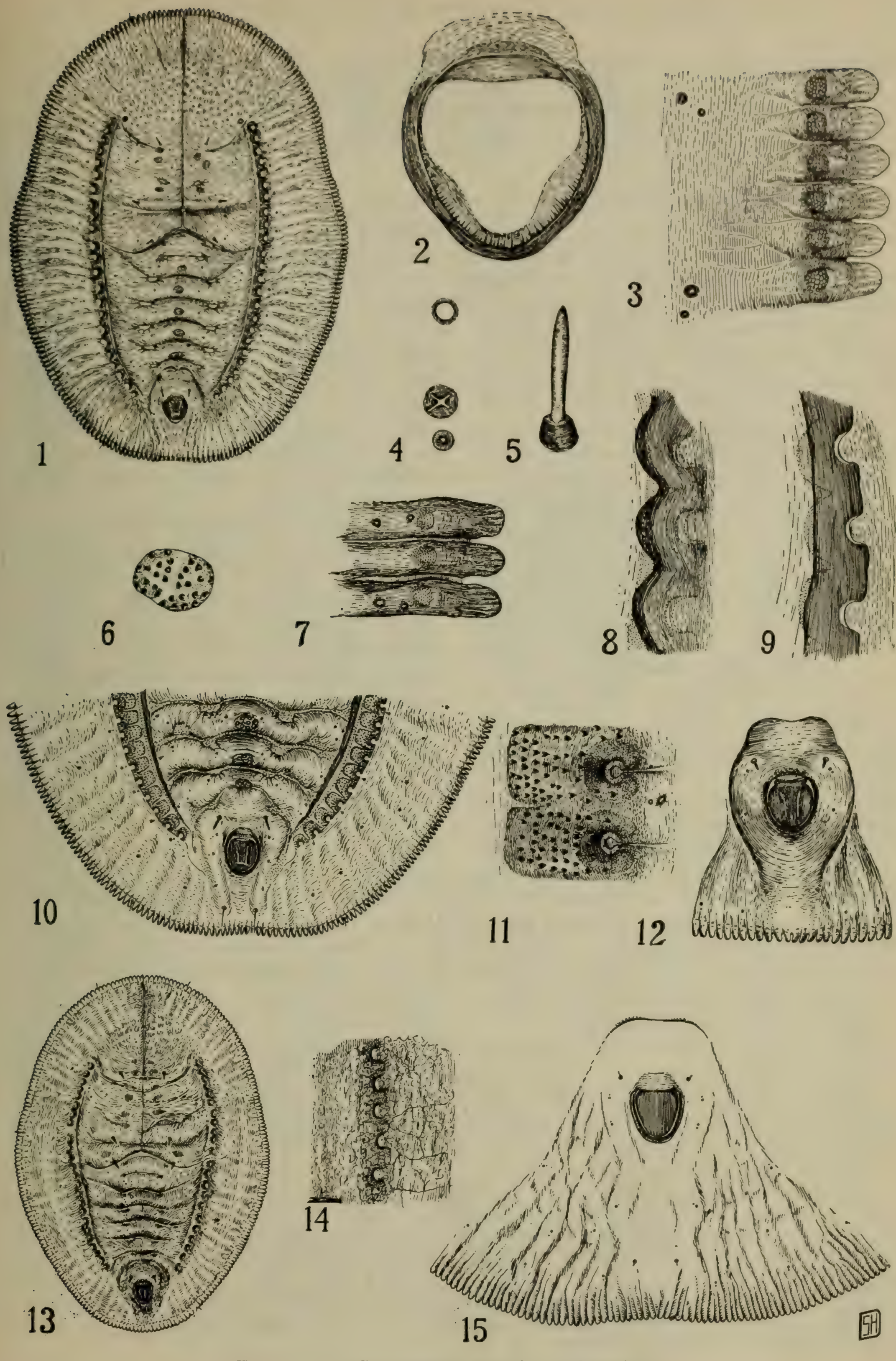
FIGS. 1–5.—*Crenidorsum tuberculatum:* 1, dorsum, ×87; 2, vasiform orifice, without operculum or lingula, ×530; 3, section of margin and submargin, ×650; 4, minute setal base, disk pore and porette, ×1,500; 5, cephalothoracic submedian seta, ×1,500. FIGS. 6–9.—*C. malpighiae:* 6, median tubercle, ×650; 7, section of margin and submargin, ×650; 8, subdorsal scallops, ventral view, ×650; 9, subdorsal scallops, dorsal view, ×650. FIGS. 10, 11.—*C. ornatum:* 10, posterior 4 segments, dorsal view, ×115; 11, plates above scallops, ×530. FIG. 12.—*C. commune,* posterior segment, dorsal view, ×165. FIG. 13.—*C. armatae,* dorsum, ×87. FIGS. 14, 15.—*C. leve:* 14, area around scallops, ×650; 15, posterior segment, dorsal view, ×165.



Figs. 1–15.—(See opposite page for explanation).

unknown, July 29, 1886 (including, holotype), and J. A. Shafer, March 13, 1913, U.S.N.H.; Guayanilla, Britton and Shafer, March 10, 1913, N.Y.B.G.; west of Ponce, A. A. Heller, November 26, 1902, U.S.N.H. and N.Y.B.G.

Crenidorsum malpighiae, n. sp.

Figs. 6–9

Differing from *C. tuberculatum* as follows: Marginal teeth as wide as long. Outer disk pores submarginal in position, the majority at inner end of submarginal teeth. A well-defined median tubercle only on abdominal segments 2–5, one sometimes suggested on segment 6, each usually divided into 3–5 smaller ones with minute, stout spines. Caudal setae as near to vasiform orifice as to body margin. No minute setae on cephalic segment.

Type.—U.S.N.M. 56966. Habana, Cuba, from *Malpighia.*

Described from 30 specimens from *Malpighia glabra* L., Vedado, Habana, Cuba, collector unknown, February 4, 1919, and C. H. Ballou, February 23, 1921 (including holotype).

Crenidorsum armatae, n. sp.

Fig. 13

Differing from *C. tuberculatum* as follows: Ends of body less broadly curved, posterior end narrower than anterior end, curved in center; body not narrowed on thorax in available specimens. Marginal teeth as wide as long. Outer disk pores submarginal in position, located at inner end of submarginal teeth, about one-fifth as numerous as teeth. A total of 22–24 scallops in each row. Median tubercles absent. Caudal setae about twice as far from body margin as from vasiform orifice. No minute setae on cephalic segment. Vasiform orifice approximately its length from body margin.

Type.—U.S.N.M. 56967. La Carbonera, Cuba, from *Coccoloba.*

Described from two specimens from *Coccoloba armata* Wright, from Cuba; paratype from Calicito, Loma de Ciego, Cienfuegos, Santa Clara, Rob Combs, August 26, 1895, holotype from La Carbonera, Oriente, E. L. Ekman, September 23, 1914, U.S.N.H.

Crenidorsum commune, n. sp.

Fig. 12

Differing from *C. tuberculatum* as follows: Marginal teeth slightly more tapered, apices narrower, approximately 13 in 100μ. Outer disk pores submarginal in position, the majority the width of a marginal tooth from submarginal teeth; 2 pairs of subdorsal disk pores on posterior segment, 0 just laterocaudad of vasiform orifice. Median tubercles absent, or barely suggested on abdominal segments 3–5. Caudal setae as near to vasiform orifice as to body margin. No minute setae on cephalic segment.

Type.—U.S.N.M. 56968. Navassa Island, Haiti, from *Coccoloba.*

Described from 30 specimens from *Coccoloba* spp., as follows: *C. bergesiana ovato lanceolata* E. Schmidt, near Port de Paix, Haiti, E. L. Ekman, March 26, 1925, U.S.N.H., and E. C. and G. M. Leonard, May 1, 1929, U.S.N.H. and G.H.; *C. laurifolia* Jacq., Navassa Island, Haiti, E. L. Ekman, October 23, 1928 (including holotype), U.S.N.H., and H. A. Rehder, January 6, 1930, A. A., and Baille La Lomas, near St. Michel de l'Atalaye, Department du Nord, Haiti, E. C. Leonard, November 26, 1925, U.S.N.H.; *C. uvifera* L., Miami, Fla., J. F. Collins, December 9, 1917, G.H. The following from the Bahama Islands: *C. diversifolia* Jacq., Rose Island, Britton and Millspaugh, January 27–28, 1905, Inagua, Nash and Taylor, October 11, 1904, West End, Little Inagua, Percy Wilson, December 21, 1907, N.Y.B.G.; *C. krugii* Lind., Fortune Island, plant collector unknown, February 2, 1888, road to South Side, Long Cay, L. J. K. Brace, December 7–17, 1905, U.S.N.H.; *C. laurifolia* Jacq., Nicolls Town, Andros Island, J. and A. Northrop, April 11, 1890, N.Y.B.G., edge of Mangrove Swamp, Hog Island, Britton and Brace, August 29, 1904, N.Y.B.G., Harbour Island,

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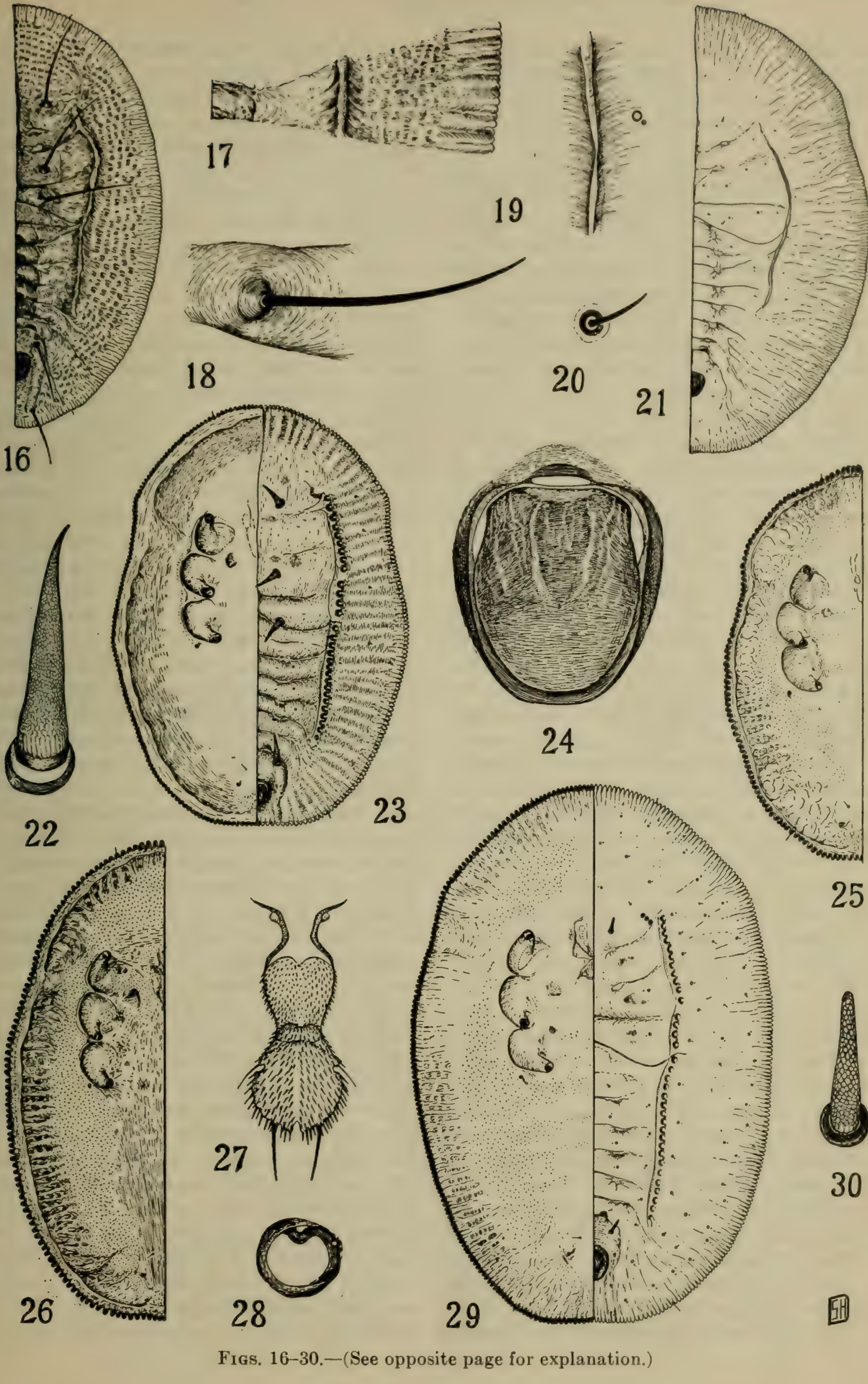
FIGS. 16–18.—*Crenidorsum differens:* 16, half of dorsum, ×87; 17, half of third abdominal segment, dorsal view, ×165; 18, cephalothoracic submedian seta, ×345. FIGS. 19–21.—*C. marginale:* 19, section of subdorsal furrow, ×650; 20, cephalothoracic submedian seta, ×1,500; 21, half of dorsum, ×87. FIGS. 22, 23.—*C. magnisetae:* 22, cephalothoracic submedian seta, ×650; 23, outline, dorsal surface on right, ventral surface on left, ×87. FIGS. 24, 25.—*C. debordae:* 24, vasiform orifice, ×650; 25, half of ventral surface, ×87. FIGS. 26–28.—*C. stigmaphylli:* 26, half of ventral surface, ×87; 27, lingula dorsal view, ×460; 28, base of cephalothoracic submedian seta, ×650. FIGS. 29, 30.—*C. diaphanum:* 29, outline, dorsal surface on right, ventral surface on left, ×87; 30, cephalic submedian seta, ×650. (Drawings by Mrs. Sara Hoke DeBord.)



Figs. 16–30.—(See opposite page for explanation.)

Elizabeth G. Britton, February 18–March 4, 1907, U.S.N.H.; *C. northropiae* Britton, near Lisbon Creek, Mangrove Cay, Andros Island, Small and Carter, January 16–19, 1910, N.Y.B.G.

Crenidorsum ornatum, n. sp.

Figs. 10, 11

Differing from *C. tuberculatum* as follows: Marginal teeth more strongly tapered, apices narrower, about twice as long as wide, approximately 15 in 100μ. Three or 4 scallops in a transverse row on cephalic segment, 30–34 in whole row, most scallops about one-half as long as height of ridge above them; outer side of ridge densely sclerotized but tending to be broken up, by less sclerotized indentations or lines running down ridges, into somewhat rectangular plates with a plate over each scallop; plates gradually increasing in size from ends of row to center, each one with longitudinal rows of heavily sclerotized, minute, stout spines; no membranous line at top of ridge but a furrow mesad of it on abdomen. Each median tubercle composed of 4–13 small tubercles each with numerous minute, stout spines. Submedian depressions and intersegmental sutures conspicuous, dotted and bordered with minute irregular areas and minute spines; mesometathoracic suture also with 2–6 pairs of longitudinal, sclerotized bars near median line; abdominal sutures extending to furrows mesad of ridges, ends of sutures 4–6 reflexed. Caudal setae 20–28μ long. Three pairs of outer subdorsal minute setae on cephalic segment. Outer disk pores approximately six times the width of a marginal tooth from submarginal teeth, about one-tenth as numerous as teeth; usually none between these and those distad of scallops, and no central subdorsal ones on cephalic segment; mesad of scallops, 1–4 (usually 2) subdorsal pairs of pores on abdominal segment 3, 1 or 2 (usually 2) on segment 4, and 1 or 2 (usually 1) on each of segments 5 and 6; submedian pair usually present on segment 6 (present in each available female, absent in only male available). Outer edge of rim usually moderately defined around anterior end of orifice. Caudal ridges and furrow rather well defined, extending nearly to submarginal teeth.

Type.—U.S.N.M. 56969. Parish of St. Thomas, Jamaica, from *Coccoloba.*

Described from six specimens from *Coccoloba longifolia* Fisch., from Jamaica: Parish of St. Thomas, N. L. Britton, September 15–19, 1908 (holotype), N.Y.B.G.; Holly Mount, Mount Diablo, W. R. Maxon, May 25–27, 1904, U.S.N.H.; Grier Field, near Moneague, Parish of St. Ann, N. L. Britton, April 3, 1908, N.Y.B.G.; Leicesterfield, Upper Clarendon, Wm. Harris, February 28, 1910, U.S.N.H.

Crenidorsum leve, n. sp.

Figs. 14, 15

Waxy secretion not observed. Differing from *C. tuberculatum* as follows: Body not narrowed on thorax. Derm colorless, membranous. Marginal teeth slightly wider than long, their sides moderately converging, their apices moderately curved; approximately 16 in 100μ. Submarginal teeth apparently absent. Ridges from margin extending through outer subdorsum, central and inner subdorsum lightly sculptured. Scallops small, some poorly defined, contiguous or not, a sclerotized furrow as long as 4–6 scallops on cephalic segment, rows terminating on abdominal segment 4, sometimes only a furrow at posterior end, 40–55 scallops defined in each row; rows curved outward on meso- and metathorax; ridge over and mesad of scallops low, rounded, a shallow furrow mesad of it. Median tubercles absent. Cephalothoracic and eighth abdominal setae tapered from base, each about 6μ long; metathoracic pair at least their length from transverse molting suture; caudal setae approximately twice as far from vasiform orifice as from body margin. Subdorsal minute setae barely distinguishable, in outer subdorsum, 3 pairs on cephalic segment. Inner subdorsal minute setal bases absent. Inner margin of disk pores circular, they and porettes very minute; outer row of pores about seven times the width of a tooth from, and about one-tenth as numerous as, teeth; pores distad of scallops about one-fifth as numerous as scallops; nearly as many pores between these rows and on cephalic segment as in them; only 1 pair of inner subdorsal pores on prothorax and 2 inner subdorsal pairs (0 just laterocaudad of orifice) on eighth abdominal segment. No transverse sculpturing along median molting suture; intersegmental sutures extending at least to inner subdorsum. Vasiform orifice semioval, broad at posterior end, 44–56μ long and wide, more than twice its length from body margin; inner edge of its rim weakly defined around

anterior end of orifice, a very short lip between it and margin of orifice. Operculum weakly or not sculptured, slightly narrower than orifice at posterior end, not quite filling orifice. Ventral surface without a submarginal furrow.

Type.—U.S.N.M. 56970. Seven miles west of Ponce, Puerto Rico, from *Coccoloba.*

Described from five specimens as follows: *Coccoloba krugii* Lind., Little St. James Island, St. Thomas, Virgin Islands, Britton and Rose, February 27, 1913, N.Y.B.G.; *C. obtusifolia* Jacq., Puerto Rico, 7 miles west of Ponce, A. A. Heller, November 26, 1902 (including holotype), A.A., and between Guayanilla and Tallaboa, J. A. Shafer, March 13, 1913, U.S.N.H.

Crenidorsum differens, n. sp.

Figs. 16–18

Differing from *C. leve* as follows: Posterior part of body narrower and less broadly curved than anterior end. Marginal teeth twice as wide as long, merely shallow crenulations, approximately 13 in 100μ. Ridges from margin ending in outer subdorsum. Scallops not actually defined but the outer side of a well-defined ridge, extending from cephalothoracic suture to fifth abdominal segment, sclerotized and tending to be divided into units suggesting scallops; no furrow mesad of ridge. A low median tubercle on each of abdominal segments 2–5. Each cephalothoracic submedian seta about 125, and each eighth abdominal and caudal seta about 100μ long, situated on tubercles; metathoracic pair the width of its tubercle from transverse molting suture. A low rachis extending from first abdominal suture to vasiform orifice. Vasiform orifice nearly twice its length from body margin. Caudal furrow and ridges unusually well-defined, reaching well toward margin.

Type.—U.S.N.M. 56971. Near Cudjoe Head, Montserrat, from *Coccoloba.*

Described from 45 specimens from *Coccoloba grandifolia* Jacq., from the Leeward Islands; near Cudjoe Head, Montserrat, J. A. Shafer, February 8, 1907 (including holotype), and Deshaies, Guadeloupe, H. Stehlé?, July 14, 1937, U.S.N.H.

Crenidorsum marginale, n. sp.

Figs. 19–21

Differing from *C. leve* as follows: Marginal teeth merely broad, short crenulations, about 18 in 100μ. Subdorsal scallops and ridges absent, replaced by a lightly sclerotized, narrow furrow; portion of furrow on cephalic segment weak and continued from rest of furrow which terminates on abdominal segment 4 or 5. Submedian mesothoracic setae absent; caudal setae about half as far apart as eighth abdominal ones. Meso- and metathorax each with 2 inner subdorsal pairs of disk pores; first abdominal segment with 1 pair of submedian disk pores; eighth abdominal segment apparently with 3 pairs of pores (1 usually laterocaudad of orifice), anterior pair on this segment laterad or cephalolaterad of eighth abdominal setae. Transverse molting suture terminating at inner subdorsal furrows. Vasiform orifice 36–42μ long and wide, inner edge of its rim well defined around anterior end, a well-defined lip between it and margin of orifice. Operculum broad at posterior end, nearly truncate.

Type.—U.S.N.M. 56972. Barahona, Dominican Republic, from *Coccoloba.*

Described from three specimens from *Coccoloba pubescens* L., near Barahona, Dominican Republic, E. L. Ekman, September 11, 1926, U.S.N.H.

Crenidorsum magnisetae, n. sp.

Figs. 22, 23

Differing from *C. tuberculatum* as follows: Columns of white, flocculent, waxy material, supported on cephalothoracic and eighth abdominal setae, rising from dorsum, their ends curved outward and downward, covering and extending beyond the body.

Marginal teeth as wide as long. Three or four scallops on cephalic segment, a total of 26–36 in each row, terminating on abdominal segment 5; the majority one-half of the width to the width of a scallop apart, not quite so long as height of ridge over them; ridge low, broad, rounded, outer side not more heavily sclerotized than subdorsum, no membranous line at its top, a furrow mesad of it. Median tubercles absent. Each cephalothoracic and eighth abdominal seta approximately 60μ long, and 14–20μ in diameter at base, elongate conical, covered with minute spine-shaped designs in a netlike arrangement, set in thin collarlike bases; the eighth abdominal ones much nearer to posterior suture than to vasiform orifice and the area around their bases somewhat swollen; caudal setae as far apart as outermost point of

bases of eighth abdominal ones, usually located distad of caudal ridges. Three pairs of outer subdorsal minute setae on cephalic segment. One pair of inner subdorsal minute setal bases on prothorax. Mesad of scallops, 2 submedian disk pores at base of each cephalothoracic seta, no submedian pair on prothorax, anterior pair of posterior segment at bases of eighth abdominal setae. Intersegmental sutures reaching to furrows mesad of scallops; abdominal segment 7 practically as long as segment 6. Vasiform orifice broadly elliptical, slightly longer than wide, scarcely more than its length from body margin, about one and one-half times its length from posterior suture, unusually high; a narrow lip at anterior end, a shallow invagination between rim of orifice and lip. Caudal ridges rather well-defined opposite and just laterocaudad of orifice.

On ventral surface a few minute spines along tracheal tract from anterior edge of inner end of thoracic tracheal folds to anterior abdominal spiracles, mesad of each leg, and around adhesive sacs.

Type.—U.S.N.M. 56973. Grande Cayemite, Haiti, from *Coccoloba.*

Described from 16 specimens from *Coccoloba* spp. as follows: *C. diversifolia* Jacq., Grande Cayemite, Haiti, W. J. Eyerdam, August 1927 (including holotype), U.S.N.H., and below Hardware Gap, vicinity of Newcastle, Jamaica, Britton and Hollick, March 1, 1908, N.Y.B.G.; *C. retusa* Grieseb., Port Margot, Massif du Nord, Haiti, E. L. Ekman, December 11, 1924, U.S.N.H.; *C. revoluta* Leonard, vicinity of St. Michel de l'Atalaye, Department du Nord, Haiti, E. C. Leonard, November 20, 1925, U.S.N.H.

Crenidorsum debordae, n. sp.

Figs. 24, 25

Differing from *C. magnisetae* as follows: Caudal setae considerably farther apart than outermost point of bases of eighth abdominal setae. Usually 2 pairs of inner subdorsal minute setal bases on prothorax. Scallops about half as long as height of ridge over them; a well-defined furrow mesad of ridge. Inner edge of rim of orifice merging with margin at anterior angles of orifice, lip absent, a rather deep invagination in center of anterior margin of orifice. Ventrally, minute spines numerous, in a band well removed from margin, starting near median line on cephalic segment, passing outside legs, greatly widened posterior to legs and terminating a little anterior to ventral abdominal setae; also present mesad of legs, but few or none around adhesive sacs. Several ridges, divided into irregularly shaped areas, between minute spines and submarginal furrow, in center of cephalic segment and on abdominal segments 2–4.

Type.—U.S.N.M. 56974. Petite Gonave Island, Haiti, from *Coccoloba.*

Described from 12 specimens from *Coccoloba rotundifolia* Meissn., Haiti, Petite Gonave Island, E. C. Leonard, July 9 and 10, 1920 (including holotype), west of Cabaret, January 12, and vicinity of Bassin Bleu, April 17, 1929, E. C. and G. M. Leonard, U.S.N.H.

Crenidorsum stigmaphylli, n. sp.

Figs. 26–28

Differing from *C. magnisetae* as follows: Marginal teeth as wide as, or slightly wider than long, their sides nearly parallel and their apices broad, approximately 8 in 100μ. No scallops on cephalic segment but a short sclerotized furrow suggestive of them; 20–26 scallops defined in each row, about half as long as height of ridge over them; a deep furrow mesad of ridge. A tongue-shaped projection extending inward from collar around base of each submedian cephalothoracic seta; caudal setae located rather near ends of posterior suture, slightly farther apart than outermost point of bases of eighth abdominal setae. Two pairs of inner subdorsal minute setal bases on prothorax and 1 usually present on abdominal segment 6. Inner edge of orifice rim merging with margin at anterior angles of orifice, lip absent, a deep, broad invagination in anterior margin of orifice. Caudal ridges opposite orifice. On ventral surface a band of ridges extending inward from submarginal furrow, majority of ridges divided into irregularly shaped areas (more distinct in mature than in recently emerged pupae), absent from tracheal folds and area adjacent to abdominal tracheal fold. Minute spines in a band reaching from ridges to submedian area, present across tracheal folds; also present around mouthparts, adhesive sacs, and legs.

Type.—U.S.N.M. 56975. Ponce, Puerto Rico, from *Stigmaphyllon.*

Described from numerous unmounted specimens and 28 mounted ones from *Stigmaphyllon;*

S. sagraeanum A. Juss. (determined by C. V. Morton, U. S. National Herbarium), Hanabanilla Falls, near Cumanayagua, Santa Clara, Cuba, H. G. Myers, April 7, 1925; *Stigmaphyllon* sp., Ponce, Puerto Rico, Martorell and Wolcott, May 20, 1937 (including holotype).

Crenidorsum diaphanum, n. sp.

Figs. 29, 30

Waxy secretion not observed. Differing from *C. magnisetae* as follows: Derm membranous, colorless. Marginal teeth slightly wider than long, their sides moderately converging, approximately 15 in 100μ. Submarginal teeth very faint, in basal part of marginal teeth. Rows of scallops terminating on sixth abdominal segment, 36 or 37 (observed) in each row. Submedian meso- and metathoracic setae absent; cephalic and eighth abdominal ones 30–40μ long, and 6–8μ in diameter at base; eighth abdominal ones located about twice as far from vasiform orifice as from posterior suture, area around their bases not swollen; caudal setae located just before bases of marginal teeth, as far apart as innermost point of bases of eighth abdominal ones. Disk pores outside scallops about one-third as numerous as scallops; submedian disk pores absent from thorax. Vasiform orifice approximately its length from posterior suture and about one and one-half times its length from body margin; a faint indication of an invagination between rim and lip at anterior end of orifice. Ventrally no submarginal furrow; ridges extending inward from margin except in and on each side of tracheal folds, majority of them divided into irregularly shaped areas; a band of minute spines mesad of ridges, extending to submedian area on abdomen, none or few mesad of legs and around adhesive sacs; very minute spine-shaped markings in median area of abdomen.

Type.—U.S.N.M. 56976. West of Cabaret, Haiti, from *Coccoloba.*

Described from three specimens from *Coccoloba rotundifolia* Meissn., west of Cabaret, Haiti, E. C. and G. M. Leonard, January 12, 1929, U.S.N.H.

ZOOLOGY.—Malacobdella minuta, *a new commensal nemertean.*[1]

WESLEY R. COE. Osborn Zoological Laboratory, Yale University, and Scripps Institution of Oceanography, University of California. (Communicated by WALDO L. SCHMITT.)

The new species of nemertean described herein is of interest because it presents several morphological deviations from the three previously described representatives of the order Bdellonemertea. This order contains but a single genus, *Malacobdella,* the species of which are highly specialized for a commensal life within the mantle or pulmonary cavities of various mollusks. One of these species, *Malacobdella grossa* (O. F. Müller), which is specifically identical with *M. mercenaria* and *M. obesa* Verrill, is widely distributed in pelecypods on the coasts of Europe and on both the Atlantic and Pacific coasts of North America. Another species (*M. japonica* Takakura) has been reported only from the coasts of Japan. The third species was found in the pulmonary cavity of a fresh-water snail in Chile.

DESCRIPTION

Malacobdella minuta, n. sp., is a dwarf form, with a combination of characteristics by which it is easily distinguished from *M. grossa,* also found on the coast of California, as well as from *M. japonica.* It differs particularly from *M. grossa* in its small size when mature, in having few and relatively large gonads, arranged in a single irregular row, in having dorsolateral nephridiopores, and in the short proboscis chamber. The chief distinctions from *M. japonica* are size, arrangement and number of gonads, length of proboscis sheath, and position of posterior nerve commissure. Minor differences from each of these species are indicated in the following paragraphs:

Length of sexually mature type specimen only 5 to 8 mm, according to state of contrac-

[1] Received September 1, 1944. Contributions from the Scripps Institution of Oceanography, New Series No. 243.

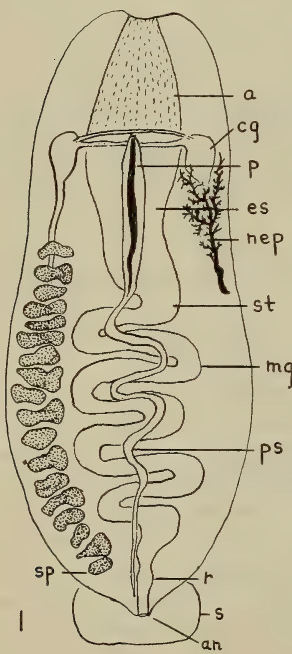
tion, as compared with 20 to 50 mm in the other two marine species. Width 2 mm.

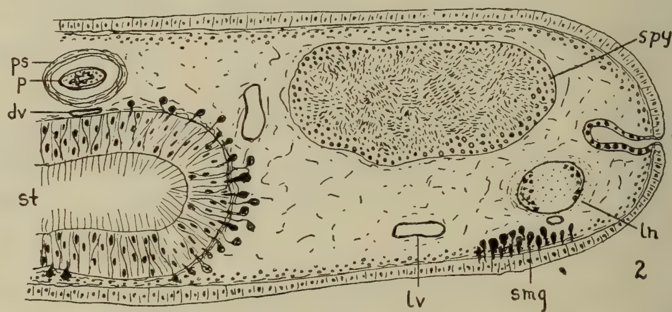
Color whitish and translucent; intestine pale yellow; spermaries opaque white.

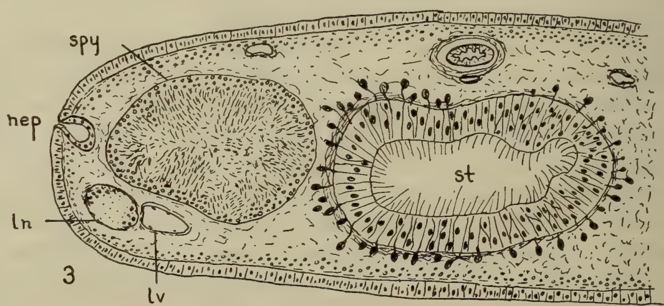
Proboscis.—The proboscis sheath extends nearly the entire length of the body, as in *M. grossa,* while this organ is only two-thirds as long as the body in *M. japonica* (Takakura, 1897; Yamaoka, 1940). The proboscis fills most of the cavity of the rhynchocoel and is therefore coiled only as much as the sheath. It has only a single chamber and this extends posteriorly somewhat less than half the length of the body (Fig. 1). After eversion it is withdrawn by a long retractor muscle which extends the entire length of the sheath. Near the base of the sucker this long, slender muscle passes through the end of the sheath and some of its fibers become interlaced with fibers from the dorsal body wall, as Riepen (1933) and others have described for *M. grossa.* The proboscis chamber is relatively much shorter and the retractor muscle correspondingly longer than in *M. grossa.*

Vascular system.—The two lateral blood vessels are much branched, as in other species of the genus, and have the usual dorsal cephalic anastomosis. In the brain region there is a second anastomosis on the dorsal side of the esophagus. From this anastomosis the dorsal vessel originates and the three longitudinal vessels are united posteriorly on the dorsal side of the rectum.

Excretory system.—The single pair of nephridia extend from near the brain through most of the anterior half of the body (Fig. 1). The profusely branching tubules lie in the parenchyma dorsal to the lateral nerves and adjacent to the main lateral blood vessels. They unite posteriorly to form a pair of large efferent ducts which lead to the exterior on the dorsolateral surfaces of the body (Figs. 2, 3). In this respect the species resembles *M. japonica* and differs from *M. grossa.* In the latter the nephridiopores are ventrolateral.







Malacobdella minuta, n. sp.: Fig. 1.—Diagram of organ systems from dorsal surface, showing atrium (*a*), anus (*an*), cerebral ganglia (*cg*), esophagus (*es*), midgut (*mg*), one of the nephridia (*nep*), proboscis (*p*), proboscis sheath (*ps*), rectum (*r*), sucker (*s*), spermaries (*sp*) and stomach (*st*). Fig. 2.—Portion of transverse section through posterior portion of anterior half of body, showing right efferent nephridial duct (*nep*) opening on dorsolateral surface. Other letters indicate: *dv*, dorsal blood vessel; *ln*, lateral nerve cord; *lv*, lateral vessel; *p*, proboscis; *ps*, proboscis sheath; *smg*, submuscular glands; *spy*, spermary; *st*, stomach with columnar ciliated epithelium surrounded by gland cells. Fig. 3.—Portion of transverse section of body, showing left efferent nephridial duct (*nep*) on dorsolateral surface. Other letters as in Fig. 2.

The efferent ducts lie at the posterior end of the nephridial system and in the region where the stomach enters the midgut. This is also the region where the lateral blood vessels move from the dorsolateral to the ventrolateral portion of the parenchyma and a short distance behind the most anterior gonads (Fig. 1).

Digestive system.—The broad atrium extends from near the tip of the head to the brain commissures where the proboscis opens through its dorsal wall. Posterior to the proboscis opening the digestive canal continues as the esophagus without change in the size of the lumen or in the character of the lining epithelium of short ciliated cells. In the region of the nephridiopores and the most anterior gonads the lumen becomes narrower, the ciliated epithelium more highly columnar and the large, subepithelial gland cells in the parenchyma on the external border of the epithelium become more numerous. This part of the gut is correctly designated as the stomach (Figs. 1, 2, 3). This specimen shows no indication of the caecum which Riepen (1933) describes as occurring between foregut and midgut in *M. grossa.* There is no abrupt change but only a gradual transition in the lumen as well as in the epithelium between esophagus and stomach and between stomach and midgut.

Posterior to the stomach the slender midgut bends alternately to left and right, forming three loops or convolutions on the right side of the body and four on the left. The midgut terminates in the median rectum which opens on the dorsal side of the sucker (Fig. 1).

Nervous system.—The two cerebral ganglia are widely separated by the broad atrium (Fig. 1) and are connected by the usual small dorsal and large ventral commissures. Each ganglion has but a single fibrous core and is without division into dorsal and ventral lobes. At the posterior end of the body the lateral nerve cords are united by a slender commissure situated on the dorsal side of the rectum and in close connection with the anastomosis of the three longitudinal blood vessels. In this respect the species resembles *M. grossa* and differs from *M. japonica.* In the latter the commissure is stated to lie in the sucker and posterior to the anus (Takakura, 1897; Yamaoka, 1940).

Reproductive system.—In the single male available for study the gonads are situated in a single irregular row on each side of the body. In this specimen, which was sexually mature, there are 18 pairs of large spermaries filled with apparently mature spermatozoa (Fig. 1). In this respect *M. minuta* differs from either of the two other marine species, in which the gonads are relatively small and very numerous. In this new species they are arranged much as in typical hoplonemerteans. Female at present unknown.

Habitat.—Commensal in the mantle cavity of *Yoldia cooperi* Gabb. Collected by Dr. Martin Johnson off Point Loma, southern California, at a depth of 40 meters.

Type in Peabody Museum, Yale University.

The four species of *Malacobdella* at present known may be distinguished by the following key:

1. Commensal in marine pelecypods..........2
   Commensal in fresh-water gastropod . *auriculae*
2. Proboscis sheath nearly as long as body; posterior commissure of nerve cords on dorsal side of rectum..........................3
   Proboscis sheath only two-thirds as long as body; posterior commissure of nerve cords in sucker..........................*japonica*
3. Nephridiopores on dorsolateral surfaces; gonads large, situated in a single irregular row on each side of body..............*minuta*
   Nephridiopores on ventrolateral surfaces; gonads relatively small and very numerous, irregularly scattered................*grossa*

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LINGUISTICS.—*Origin of the word "maize."*[1] JOHN P. HARRINGTON, Bureau of American Ethnology.

"Corn" is the same word as "grain." Corn comes from the Anglo-Saxon, grain from the Latin, the two forms being different pronunciations of the same word, which originally referred to any kind of grain. As late as in the time of Queen Elizabeth in England "corn laws" were enacted. Needless to say, they did not refer to Indian corn but to any kind of grain.

When America was discovered, a new kind of seed grass was seen for the first time, the kernels of which were so large and delicious that there was nothing like them in Europe. The Spanish discoverers did not know what to call this plant, which is now known in English as Indian corn, or simply as corn. One of the early Spanish writers termed it bledo de las Indias, wheat of the Indies.

Oviedo was a Spanish writer and student who made his home at Puerto Plata (Silver Harbor) on the island of Santo Domingo for 20 years or more, perhaps from 1520 to 1540. During this period he was writing his *General and tribal history of the Indies.* The native Indian languages of the West Indies were still spoken at this early time, which was only a few years after the discovery of the islands by Columbus. Oviedo, whose full name was Gonzalo Fernández de Oviedo y Valdés, is the only writer who shows how the Indians were abused and makes it apparent how they later became extinct through the introduction of colored slaves. His book remained in manuscript form 311 years, until it was printed in Madrid, Spain, in 1851 and was thus made available to historians of the modern world. By the time this history was published the Indian language had long since given way to Spanish in the islands. Any Indian words that Oviedo writes about are therefore important, for what he says constitutes perhaps our only source of definite information.

The word "maize" is first recorded by Oviedo as the word for corn in the Cuban dialect of Arawak, and he gives the native original form in two spellings: "maisi" and "majisi." What is the phonetic interpretation of these spellings? It is that the word starts off with mah-, which is followed by -hi- (this syllable in colloquial Spanish reduced to the second member of a diphthong), and the word is then closed by a third and final syllable -si. By giving two spellings Oviedo makes it possible to know exactly what the pronunciation was. Though the Arawak language has for centuries been dead in the islands, there are Indians on the mainland of South America, for instance, in Guiana, who still speak a different dialect of it, and in their dialect, if we look for the word for corn, we find "marise." Why should -r- take the place of Oviedo's -j-? No one knows.

This old native Cuban word for corn was taken into Spanish as maíz—with an accent written on the i to show it is a separate syllable. In Spanish dialects the word is often pronounced the same as English mice (plural of mouse), but in more "highbrow" Spanish it should be ma-ís, with the accent on the second syllable. It will be seen that only the -j- and final -i of Oviedo's word are missing. This Spanish word is the name for corn in practically all the languages of Europe and Asia except English, in which the old inherited word corn, taking on a new restricted meaning, has knocked it out. The Carib Indian work for corn is similar to and cognate with the Arawak Indian word for corn.

The botanical name of the plant, *Zea mays,* was given by none other than the great Linnaeus, father of modern botanical nomenclature. But Linnaeus spelled the word "mays" wrongly. Spanish z is pronounced in the New World as s, but the writing of y instead of i is far from the spelling given by Oviedo.

What is the etymology of this old Arawak word for corn, which has come to be on the tongue of German, Russian, French, Italian, and Hungarian? To what verb is it perhaps related? This again no one knows.

[1] Received August 21, 1944.

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ETHNOLOGY.—*The Sinhalese caste system of central and southern Ceylon.*[1]

WILLIAM H. GILBERT, JR., Library of Congress. (Communicated by W. N. FENTON.)

The caste system of India is a growth of such vast dimensions that it requires an approach by local surveys of a fairly intensive nature before any relevant ideas can be acquired concerning the structure as a whole. Geographically there is a wide range of variation in the development of the caste relations from the more complex groupings of the Ganges Valley to the simpler units of the peripheral areas such as the Laccadives and Ceylon. It seems both logical and easier to commence a series of local surveys with the areas of simpler development and gradually work up to the more complicated relations in areas of central caste specializations.

In Ceylon the number of castes is fewer and the complexity of their relations is much less marked than on the mainland in India proper. European penetration has to a greater degree than in India broken down the indigenous system of social and economic stratification. This process of economic change, if properly studied, should as a clear example be an aid to the understanding of the caste relationships both here and elsewhere in India.

Ceylon is divided primarily between two peoples, the Sinhalese of the south and central areas and the Tamils of the north. The former number over 3,500,000; the latter about 790,000, or 15 percent of the total. In addition there are about 325,000 Moors, or Mohammedans, on the coasts of the northeast and northwest. The Sinhalese and the Tamils each possess a caste system peculiar to their own nationality. The Tamils, being in a minority and sharing the social stratification of their fellow nationals in India, are not considered in this paper except where they show relationships with the Sinhalese. The Moors do not appear to have castes.

The most important items of inquiry to which the present paper is devoted relate to the identity of the Sinhalese castes, the nature of their membership, their location past and present, their origin, and their differences in customs and manner of life. By assembling the known facts concerning Sinhalese social stratification it is possible that a contribution will be made not only to the understanding of caste in India but to the science of human social stratification in general.

HISTORICAL BACKGROUND

According to Arthur Perera (1917, p. 26)[2] the Sinhalese castes probably had a tribal basis. The lower castes, he says, formed tribes of a prehistoric Dravidian race, the *Rakshas* of tradition, who drove into the interior the still earlier Australoid Veddas, who were the *Yakkas* of tradition. Later the higher castes of northern India entered Ceylon, and the frequent subsequent contacts with the Deccan in historical times led to the formation of the artisan castes.

The original Sinhalese Kingdom comprehended most, if not all, of the present Island

[1] Received November 28, 1944. The transliterations of Sinhalese words in this paper are presented as they are given in the literature. It will be noticed that some of the caste names have a variety of spellings. Some writers use ch for c, sh for s, c for ś. Coomaraswamy in his work on *Medieval Sinhalese Art* gives a clear and consistent system of transliteration. Appendix IV at the end of this paper gives an official transliteration of the main caste names.

[2] Complete references are given in the Literature Cited.

of Ceylon and was founded, according to historical tradition, about 504 B.C. by Vijaya, an immigrant chief from either Bengal or Gujarat. Among other elements of culture that he is credited with having introduced into Ceylon the caste system was notable. Vijaya's Sinhalese appear to have colonized the entire southern part of Ceylon, both highland and lowland, displacing the aborigines as they proceeded. Later accounts tell of continued struggles with the Tamils in northern Ceylon, but whether these Dravidian people arrived at a prior date is subject to dispute.

The contests between the apparently Aryan Sinhalese and the Dravidian-speaking Tamils continued until A.D. 1505, when the coming of the Portuguese introduced European influences for the first time. The explorers and colonists from Portugal were able to subdue only the lowland coastal areas. Here they carried on a brisk trade in cinnamon bark and converted about a tenth of the natives to the Roman Catholic faith. In the highlands the independent Sinhalese of Kandy succeeded in maintaining their Buddhistic traditions, caste customs, and economic life in relative independence. The impress of 133 years of Portuguese rule still remains in the culture of lowland Sinhalese today and helps account for their many differences from the highlanders or Kandians. The economic life of the lowland castes was affected by the European overseas plantation culture, while the aboriginal economy of the interior castes was largely medieval and self-contained.

The Dutch attacked the Portuguese forts in Ceylon about 1638 and in a series of sanguinary campaigns completely ousted them from their coastal settlements by 1658. They were aided by disgruntled Sinhalese whose caste system had been disrupted by the impressment of men of high caste as coolie labor by the Portuguese. For more than a century the Dutch now monopolized the cinnamon trade and firmly installed the Romano-Dutch law among the lowland Sinhalese. The Cinnamon-peeler caste was greatly augmented by many new recruits during this period, and friendly relations were maintained with the independent Kandian Kingdom of the interior.

In 1795 the English assailed the Dutch colony of Ceylon and added it to their growing domains in British India. Later, Ceylon was separated as a Crown colony. Within a few years continued conflict with the native independent Kandians was terminated by the conquest of the highland area by the British, and the native dynasty was extinguished. The Kingdom of Kandy in 1802 was still organized on the basis of an interchange of goods and services between castes as part of a vast native civil service dependent upon the king and his nobility for its existence and stability. With the introduction of British rule this system rapidly collapsed, and a European plantation economy, marked by the cultivation of coffee, tea, cacao, rubber, and other tropical products, was introduced into the highlands.

The castes that had formerly performed certain functions exclusively were now forced to take up vocations outside of their former sphere, although they still maintained to a large degree their restrictions on intermarriage with other castes.

DIFFERENCES FROM INDIA

According to Denham the Sinhalese caste system differs in the following respects from the system in India proper (Hayley, pp. 146–147):

(1) The Sinhalese, being of a homogeneous race and religion, do not have the complexity of Indian castes, with their mingling of tribes, races, and religious orders.

(2) The Sinhalese castes are more or less alike in language, dress, and customs, with a few notable exceptions, whereas the Indian castes differ greatly in these items.

(3) Buddhist tolerance in matters of caste has eliminated the technical religious sanctions and complicated rules prevailing in India.

(4) There are no Brahmans in the Sinhalese caste system, and their place is taken by the comparatively autocratic central government in the native kingdom.

(5) The native Kandian Kingdom, by organizing the people under state departments each under the control of a crown officer, supplied the economic needs of the realm. Thus a system of state socialism was effected by hereditary occupations under official direction.

(6) Sinhalese caste emphasizes duties, while Indian caste is concerned with customs and habits.

(7) In the Sinhalese system no distinct order of precedence of castes seems ever to have been agreed upon.

(8) The religious sanction is lacking in the Sinhalese system, but popular psychology and government control operate through the *ninda* overlords and the authority of the native courts to enforce the caste rules.

(9) In Sinhalese society such matters as legal rights and liabilities, distinctions of name, salutation, comfort of living, liability to degradation to slavery, and penal restrictions all help to maintain caste. In India proper slavery is rare, legal rights are interpreted by the Brahmans rather than by royal officers, and other bases of caste distinction are imposed.

SOURCES

The literature describing caste as it has developed among the Sinhalese is not extensive. From 1665 until the present time about 30 writers have listed, with varying degrees of completeness, the names of the Sinhalese caste groups. The number listed runs from 7 to 63. Most of these writers content themselves with merely itemizing the castes and furnishing a few characterizations of major groups. Some list the castes in their order of strength or membership, others in their hierarchical status from highest to lowest; while still others classify the castes in terms of their occupational specialties. Alphabetical lists are not given, possibly because of the mixture of English and native terms used as caste names.

OCCUPATION AND STATUS

The titles or names of the castes are primarily occupational, but there exists a rich synonymy of terms, especially euphemistic titles, which are inspired by the native politeness and well-bred manners of the Sinhalese. The Cultivators rank highest, followed by the Fishermen, Toddy-drawers, Cinnamon-peelers, etc. (Upham, vol. 3, pp. 352–353). At the base of the system are the *Rodias*, or Outcastes, a group of wandering beggars.

Social status, while ostensibly based on occupation, is probably in the main dependent upon numbers and racial background. The most numerous caste, the Cultivators, or *Vellalas*, constitutes about two-thirds of the Sinhalese population and also ranks highest in status. Persons of low caste are traditionally descended from groups outcasted by royal action or of low degree because imported from beyond Ceylon. Some of the caste terms are synonymous with those used by the Tamils and the Malayalam-speaking peoples. Such terms are *Vellala* (Cultivator) and *Achari* (Smith, or Artisan). The occupational spe-

FIG. 1.—Map of Ceylon, showing in schematic fashion the general location of certain Sinhalese castes, Tamils, and Moors. *Solid line:* Boundary between Sinhalese and Tamil-Moor areas. *Dotted line:* Boundary between coastal, or lowland, Sinhalese and Kandian, or highland, Sinhalese. *1*, Agriculturists; *2*, Cinnamon-peelers; *3*, Drummers and Weavers; *4*, Fishers; *5*, Jaggery-makers; *6*, Lime-burners; *7*, Mat-weavers; *8*, Outcastes, or *Rodias; 9*, Potters; *10*, Smiths and Artisans; *11*, Toddy-drawers; *12*, Veddas; *13*, Washers; *14*, Tamils; *15*, Moors, or Mohammedans.

cializations of particular castes and their grouping resemble the system found in southern India. For example, the phrase "five performers of services," or "five village servants," is used in both the Sinhalese system and the Indian in referring to the Carpenters, Weavers, Washers, Barbers, and Shoemakers (Coomaraswamy, pp. 178–179).

In older times there were basic distinctions in dress, dwelling types, and character of food between the castes, which were imposed by sumptuary laws under royal command (see infra). Nowadays these differences have largely gone by the board. Almost the only outstanding remaining distinction is the restriction on intermarriage. The land rights and duties of the various castes under royal command have all lapsed since the abolition of compulsory labor or Rajkariya in 1832, and one cannot as a rule be sure of telling a man's occupation from his caste. With the disappearance of the occupational character of caste restrictions has gone also the ecological linkage whereby particular artisan castes were located in the special localities that furnished the raw materials for their work. Free movement from one place to another is now possible for all, while under the old native system the lower castes were attached to their estates (Ferguson, p. 135).

Slavery was permitted under the native regime, but no one could hold slaves of a higher caste than himself. The villages were classified in accordance with the caste groups that predominated among their inhabitants. Thus we find Outcaste villages, Cinnamon-peeler villages, etc. In southern India the larger cities of towns had special streets for individual caste groups. Each person was identified by his "ge," or house, name, which referred both to his caste and to his caste village (Denham, pp. 178–179).

In addition to distinct traditions of origin some of the castes formerly possessed badges or ensigns peculiar to their own group and symbolical of traditional events or objects connected with their history or occupation. Thus the Fisherman caste, or *Karawe*, had a fish on their flag, while the Artisans, or Smiths, had an ape, the symbol of Hanuman, king of the monkeys and prominent in their legends (E. W. Perera, pp. 20–23).

BUDDHISM AND CASTE; ROMAN CATHOLICS

The Buddhist religious functionaries have in the past been selected entirely from the *Goigama*, or Cultivator, caste since the respect required for the religious office could be consistent only with one of high caste. The higher grades of castes that rank immediately after the *Goigama*, however, are not professedly excluded from the religious worship of the Buddhist faith by any formal ordinances. Lay brothers of low caste called *Silvat* frequently led a life similar to that of the *Goigama* functionaries and performed minor religious duties. These low-caste officials were not, however, formally ordained, nor were they treated with any distinction (Pridham, vol. 1, p. 313).

The Siamese sect of Buddhists was founded about 1750 and had its stronghold in Kandy. It admitted only *Goigama* to its membership, which constituted about half of all Sinhalese Buddhists. The *Amarapara* and *Ramanya* Buddhist sects were both founded later than the Siamese sect and under Burmese influences. They, in contrast with the Siamese sect, profess to admit all castes to their membership but in reality are asserted to admit only *Karawe*, or Fishers, along with Cinnamon-peelers and Toddy-drawers, the three highest-ranking castes next to the Cultivators. The *Amarapara* and *Ramanya* predominate in the low country and now constitute about 34 and 16 percent, respectively, of the Sinhalese Buddhists. In the highland area these two sects together constitute less than 10 percent of the Buddhist Sinhalese. Although in the lowlands the Siamese sect numbers only about 20 percent of the Buddhists, they own all the temples (Copleston, pp. 250–252).

Sinhalese Buddhism is not alone in its tolerance of caste, since we find that the Buddhists of Kashmir, Nepal, and ancient Hindustan also maintained caste differences. As in orthodox Hinduism, persons engaged in occupations requiring the killing of and contact with dead animals or human

beings, such groups, for example, as grave-diggers, butchers, executioners, fishermen, and leather-workers, are all outcasted.

About 10 percent (300,000) of the Sinhalese are Roman Catholics. This group is mainly located in the lowlands and consists of converted Fishers, Cinnamon-peelers, Toddy-drawers, Washers, and Cultivators. The Ceylon police records under the title of "Hue and Cry" in the Ceylon Government Gazette showed during the period 1905–1907 the following numbers of Roman Catholics among Sinhalese castemen: *Goigama*, 935 persons, 68 R.C., or 7 percent; *Karawe*, or Fishers, 158 persons, 60 R.C., or 38 percent; *Halagama*, or Cinnamon-peelers, 98 persons, 21 R.C., or 20 percent; *Wahumpura*, or Jaggery-maker cooks, 94 persons, no R.C. because this is primarily a highland caste; *Durawe*, or Toddy-drawers, 69 persons, 12 R.C., or 17 percent; and *Radaw*, or Washers, 34 persons, 4 R.C., or 11 percent.

RELATIONS TO THE MALDIVIANS AND TO THE TAMILS

The Maldive Islands to the southwest of Ceylon are inhabited by a Moslem people whose speech is related to Sinhalese. It is generally believed that the culture of the archipelago stems historically from Ceylon. The various writers who first reported on the Maldives detailed four major caste groups—(1) the *Bandara*, or royal caste, which was composed of the sovereign and his relatives, (2) the *Didus*, or persons of high dignity who might intermarry with royalty if specially permitted and carried hereditary titles of nobility, (3) the *Manike* or *Maniku*, who were the gentry, and (4) the *Kalo*, or *Kamulo*, the common people, made up of artisans, tradesmen, and persons engaged in ordinary occupations. Apparently the nobility was more of a class than a caste, especially in relation to the first rank and since some were given titles from the gentry (Bell, 1917; Hockly, p. 111).

The *Maniku* would seem to correspond closely with the *Goigama*, or Cultivator, caste, while the lower Sinhalese castes would correspond with the *Kalo*. It is noticeable that the Moslems or Moors of Ceylon itself are divided into four classes: merchants, weavers, fishermen, and barbers. The Maldivian occupational equivalents to the lower Sinhalese castes occur in the following examples: Fishers, Lac-workers, Mat-weavers, Carpenters, Goldsmiths and Silversmiths, Blacksmiths, Tailors, Barbers, Masons, Weavers, and Toddy-drawers. The available literature does not indicate, however, that these occupations were hereditary and characterized by in-marrying restrictions.

Among the Tamils of the north and east of Ceylon the occupational-caste equivalents to many of the Sinhalese castes are to be found. The following are the most important of these (based on Chitty, pp. 231–234): Cultivators (Tamil *Vellala* are divided into four groups, which are the equivalents of the *Goigama*); Herdsmen (Tamil *Idayer* are equivalent to the *Pattiwala Aya* subdivision of the *Goigama*); Fishers (the Tamils have six castes in this category as the equivalents to the *Karawe*); Toddy-drawers (Tamil *Nalawers* and *Shanavars* are equivalent to the *Durawe*); Lime-burners (Tamil *Kadeyers* equivalent to *Hunno*); Palanquin-bearers (Tamil *Chiviyars* equivalent to *Paduwo*); Weavers (Tamil *Seniyers* equivalent to *Chalias* and *Berawayo*); Tomtom-beaters (Tamil *Parreyar* equivalent to *Berawayo*); Barbers (Tamil *Navider* equivalent to *Embattayo*); Blacksmiths (Tamil *Kaller* equivalent to *Camburo*); Goldsmiths (Tamil *Tattar* equivalent to *Navandanno*); Brass-founders (Tamil *Kannar* equivalent to *Lokuruwo*); Carpenters (Tamil *Tatcher* equivalent to *Vaduvo*); Masons (Tamil *Sitper* equivalent to *Galvaduvo*); Tailors (Tamil *Paver* equivalent to *Hannali*); Potters (Tamil *Kusaver* equivalent to *Badahelayo*); and Washers (Tamil *Wanna* equivalent to *Radaw*).

ECOLOGICAL FACTORS

The principal varieties of environment in the Sinhalese area of Ceylon are: (1) the forests of the uplands, (2) grassy areas of both upland and lowland, (3) cultivated area of upland and lowland, and (4) the coastal areas. Each of these environmental

types requires a definite mode of life, and the castes that fit one type may not be well adapted to life in another. In the forested uplands dwell the Veddas, the nearest equivalents to the hill tribes of the south Indian mainland. The Veddas are divided into settled and wandering groups. The economy of the wandering Veddas involves a competition with bears for the fruits and wild honey of the forests and with the leopards for the deer and wild boar, which they hunt in both pasture and forest.

Under the native regime the *patena*, or grassy areas, of the western part of the Island were used for pasturage rather than for cultivation. The *talamas*, or grassy meadows, on the eastern side of the Island were scarcely utilized at all. In the northwest coastal semidesert areas population was also sparse. The Sinhalese part of the Island was divided from the Tamil by a forest band running from the northwest to the southeast and including much of the highland areas.

The cultivated areas were mainly inhabited by the *Goigamas* and their allies. The upland areas included terrace cultivation of rice, while the lowland cultivation was in the river basins near the sea. In the upland the *Goigamas* cultivated cocoa, tea, rubber, and in modern times coffee. The occasional broad and marshy plains of grass were not much used in cultivation. In the upland the kitul palm furnished the jaggery or palm sugar extracted by the *Hakuru* caste, the grasslands material for the Grass-cutter caste and for the Mat-weavers, while the clayey river beds and fields furnished material for the Potter caste. The cinnamon tree flourished in the lowlands and furnished a basis for subsistence to the *Chalia*, or Cinnamon-peeler, caste. In this area also occurred the coconut palm, the basis of toddy and the subsistence of the Toddy-drawer caste. Finally, on the coastal or maritime area proper were the *Karawe* caste—fishermen, carpenters, and handymen of the castes. In addition to the above-mentioned crops the lowlands permitted the growth of rubber, citronella grass, and the areca palm. The last was the basis of betel chewing.

For each of the occupational castes, then, can be plotted an area of distribution in terms of the location of minerals, plants, animals, topographic features, and climatic characters most intimately related to the caste activities. These caste areas of distribution tend to cluster around highland and lowland and thus reinforce the basic distinction in mode of life between Kandians and lowlanders.

The castes were linked together in the production and servicing of items of material culture. For example, the *Achari*, or Blacksmith caste, constructed the chunam boxes to hold the betel-nut and the areca-nut cutters, the Lime-burner caste produced the lime that must be chewed with the betel, while the areca palm was cultivated by *Goigamas*. As another example the building and operation of Buddhist temples required the services of carpenters in the Artisan caste, of stone workers also in that caste, of Cultivators, Painters, Tomtom-beaters, Washers for temple linen, of Potters for sacred vessels and of Ivory, Lac-, and Wood-workers. Thus a fine degree of cooperation was required, involving the products of several different types of environment. Since the most of the castes lived by the material goods produced or services rendered, they appear to have been definitely linked with the ecological areas of the Island.

Not only were the castes localized in terms of environmental materials but they also had their own streets and quarters in the towns, as we have already intimated. Thus Pridham in his account of Ceylon (1849, vol. 2, p. 682) mentions that the site of Madoola still had in his time straight fields bearing the names of streets, such as Tomtom-beaters' Street, Potters' Street, etc.

Localization of Sinhalese castes can be determined specifically by their classified sources of livelihood. The latter may be roughly divided into four categories, animal, vegetable, mineral, and special services. The castes exploiting animal resources are: (1) the nonsettled Veddas, who subsist on honey and on deer and wild boar and consequently live mainly in the hill forests; (2)

the Elephant-catchers, who must also haunt the hill forests; (3) the Fishers, who subsist on edible marine fish on the coasts and coastal rivers in the mangrove and palm areas; (4) Scavengers and Leather workers, who, along with the Pastors, inhabit the sections in which stock abounds, i.e., primarily the cultivated lowlands; (5) the Lac-collectors and workers who are dependent on the hill forests where the trees inhabited by lac insects are found.

The castes exploiting vegetable resources are (1) the *Goigama*, who depend primarily on rice and vegetables and who are found in the areas of coastal and upland rice cultivation; (2) the Cinnamon-peelers, who are definitely limited to the western and southern coasts where the cinnamon tree abounds; (3) the Jaggery-makers, who are situated mainly in the highland areas of the kitul palm and other sugar-bearing trees; (4) Toddy-drawers, who tap mainly the coconut palm, a tree found in the long settled coastal areas of the south and west; (5) Grass-cutters, who are mainly in the grassy uplands; (6) Tree-fellers, who were timber cutters in the hill forests; (7) Weavers, who were located in the areas that produced cotton, namely, the highlands; (8) Mat-weavers, who wove materials such as rattan and reeds found in the upland grassy and swampy areas; (9) Basket-makers, who were similarly employed and lived in similar areas; (10) Gardeners, who cultivated flowers in the uplands areas; and (11) Carpenters, who subsisted by their labor on economic woods from the hill forests.

The castes whose major source of livelihood lies in mineral resources are (1) Potters, who were wont to collect their clay from cultivated areas (ricefields) and riversides in the uplands; (2) Smiths, who were located in the uplands near the sources of iron ore, which latter was extracted for them by the *Yamannu;* (3) Gem-collectors, a division of the *Goigama* who haunted the river beds and earth deposits of the Ratnapura region in the highlands; and (4) Lime-burners, who burned coral rock, wood, and other materials for lime and charcoal in both upland and seacoast.

The service castes, whose major duties were ceremonial and sumptuary, were (1) Barbers, located at the royal court; (2) Palanquin-bearers, who were mainly in demand at the royal court or the towns of the overlords; (3) Tomtom-beaters, who were most important in services connected with planet and devil worship and with temple rites; (4) the Dancers, who were similarly employed and located; (5) Washers, who served all the castes in rites of ceremonial purification and whose location was consequently the same as the other groups; (6) Tailors, who were located at the royal court in Kandy, as were also (7) the Silversmiths and Goldsmiths.

CASTE NUMBERS

No available census records exist of Sinhalese caste numbers. Evidently the European administrators of Ceylon thought that it was possible to make this social phenomenon disappear by ignoring it. According to Coomaraswamy the most important caste groups in the Kandian population are: *Goviyo* (*Goigama*); *Kamburu* (*Navandanna* and *Galladdo* artificers); *Vaduvo* (Carpenters and Blacksmiths); *Radav* (Washers or Dhobies); *Duravo* (Toddy-drawers); *Kumbakarayo* (Potters); *Beravayo* (Musicians, Weavers, Astrologers); and *Paduvo* (servile Cultivators, Palanquin-bearers) (Coomaraswamy, p 22).

An examination of the caste data reported in the "Hue and Cry," or Ceylon police records, for 1905–1907 shows the following (1) numbers, (2) percentages, (3) estimated number in the gross population, and (4) (where available) the number shown by the 1901 census of occupations: *Goigama*, 935, or 60 percent, est. 1,400,000; *Karawe*, 158, or 10 percent, est. 237,000. Fishers by occupation 38,504; caste not recorded, 104, or 7 percent; *Halagama*, 98, or 6 percent, est. 147,000; Cinnamon-peelers by occupation 15,222; *Wahumpura*, 94, or 6 percent, est. 141,000 (Cooks of Jaggery-maker caste); *Durawo*, 69, or 3 percent, est. 103,000, Toddy-drawers by occupation 11,836; *Radaw*, 34, or 2 percent, est. 51,000, Washers by occupation 29,749; *Navandanna*, 26, or 1.5 percent, est. 39,000,

Goldsmiths and Silversmiths by trade 14,361; *Hunno*, 23, or 1.5 percent, est. 34,000, Lime-burners by occupation 870; *Salagama*, 16, or 1 percent, est. 24,000 (Weavers); *Batgama*, 13, est. 18,000 (Laborers); *Duraya*, 13, est. 18,000 (Laborers); *Paduwa*, 13, est. 18,000 (Laborers); *Hakuru*, 7, est. 10,000, Jaggery-makers by occupation 803; *Berawa*, 5, est. 8,000, Tomtom beaters by occupation 1,649; *Oliya*, 5, est. 8,000, Dancers by occupation 5,423; *Badahela*, 5, est. 8,000, Potters by occupation 9,678; *Pannaya* 3, est. 4,500 (Grass-cutters); *Badala*, 2, est. 3,000 (Silversmiths); *Rodiya*, 2, est. 3,000 (Beggars); *Hedidemala*, 2, est. 3,000 (*Tamils*); Vedda, 1, est. 1,500 (Primitive Hunter); *Parava*, 1, est. 1,500 (Tamil); *Pannaderia*, 1, est. 1,500 (Grass-cutters); *Demalagattera* 1 est. 1,500 (Tamil Slaves); and *Porokara*, 1, est. 1,500 (Axmen).

It can be safely assumed that the traditional caste occupation is generally disregarded today. A very small minority of the *Karawe* are fishermen; of the *Halagama* cinnamon-peelers; of the *Durawo* toddy-drawers, etc. On the other hand, the great majority of the *Goigama* are still rice-cultivators; of the *Radaw* washermen and of the *Navadanna* goldsmiths. Pieris (n.d., vol. 2, pp. 256–258) asserts that the Portuguese first violated traditional occupations by forcing large numbers of the *Goigama* to do coolie labor, and other sources assert that the Dutch were likewise guilty of violations of caste regulations in regard to occupation (Tennent, 1889, vol. 2, pp. 123–124).

CASTE SERVICES, VILLAGE TYPES, AND SUMPTUARY LAWS

In the native Kingdom of Kandy there existed a system of forced labor, the so-called *rajkaria*, in which royal authority was employed to allocate the different occupations of the realm among the available labor supply. Families performed the tenant services by turns, i.e., alternating in giving their services under public officers in return for their land holdings. At a late date the labor services might be commuted by a money payment (Coomaraswamy, 1908, pp. 22–24).

Some of the more important lines of special service performed in the native Kandy Government included messenger or guard duty (*Atapattu vasama*); husbandman (*Ganvasama*); military duty (*Heva vasama*); artificer work (*Badal panguva*); potter work (*Badahela panguva*); musician (*Davul panguva*); washermen service (*Rada vasama*); servant (*Nila vasama* or *Uliyam vasama*); iron-smelting (*Yamanna*); and outcaste services (*Rodiya*). (*Ibid.*)

There are six departments in the Kandian Government, as follows: *Kottalbadde*, or Artificer's Department; *Badahelabadde*, or Potters' Department; *Radabadde*, or Washers' Department; *Handabadde*, or Mat-makers' Department; *Kuruwe*, or Elephant Department; and *Madige*, or Carriage Bullock Department (D'Oyly, pp. 7–18). Each department was organized with a hierarchy of officials responsible for the performance of duties by the particular castes concerned with work in that department.

The work of the departmental officials was made easier by the caste segregation in specific villages. In fact, each village was classified according to the type of caste or service to which it belonged. The following were the more important types of village: (1) *Gabada-gama*, a royal village or manor that was the private estate of the king and consisted of crown lands cultivated under the half-share system; (2) *Bat-gama* villages inhabited by the *Paduwo* caste of low status (their services included carrying the hinder parts of palanquins, watching the house or fields, and other menial work), who could never acquire any permanent rights to the land; (3) *Biso-gama*, or royal villages set apart for the *Pallervahala* or queen's palace or for the royal household on the same terms as the *Gabada-gama* (this type of village, along with the first and second, was inhabited by degraded castes who as tenants could be ejected at any time in favor of some other caste at the will of the king); (4) *Vihara-gama* type villages belonged to some Buddhist temple and services were performed for the priesthood; (5) *Devala-gama* were villages belonging to some Hindu temple or deity with services as in (4); (6) *Nindagama* was a

village under the entire protection of a local chief or landlord, and tenure of land was conditioned by service to him; (7) *Vidanegam* was a village of low-caste people liable to public services under *Vidanes*, or headmen; (8) *Wedi-gama* were villages inhabited by Veddahs; (9) *Gattaru-gama* were inhabited by persons who had been outcasted by the king; (10) *Gahala-gama* were inhabited by executioners, scavengers, and persons of extremely low caste; and *Kuppayama* were villages of *Rodiyas*, the hereditary outcaste beggars. (Denham, pp. 191–193; Coomaraswamy, p. 27.)

Not only were the castes segregated in terms of departmental services and village residence, but they were strictly regulated as to the goods they might use for clothing and the kinds of houses they might inhabit. Barbers wore doublets but could not sit on stools. Potters wore no doublets and could not sit on stools. Only the king could wear certain types of gold or silver jewelry, an eight-cornered hat, shoes, stockings, or trousers, be served with an umbrella, or live in plastered walls under tiled roofs and in two-story dwellings. (Knox, in Philalethes, p. 138.)

According to Pridham (1849, p. 597), at one time there was a thriving trade in carved figures portraying the native castes at the town of Matura. Between the low and high castes there were many invidious distinctions of dress. No low-caste woman was allowed a neck ornament except one of the Potter or Smith caste. She could not wear clothing above the waist except in cold weather. Low-caste men were not allowed to wear colored cloth or cloth embroidered with colored thread in Kandy or in the presence of higher castes. (Pamatella, p. 119 ff.).

NAMES AND CASTES

The *ge* name is a surname used before the personal name—a praenomen—and is so called because of the ending *ge* or *geyi* generally affixed to such surnames. The word *varige* and *vasagana* are used to express these surnames. The *ge* name is the most important part of a Sinhalese proper name as it usually reveals the rank, occupation, residence, caste, native place, or some characteristic or achievement of the original ancestor of the family bearing the *ge* name. Thus *Bentarahunuge* indicates a Lime-burner caste (*Hunu*) and the type of village (*ge*) whence the person came. Persons of Washerman or Barber caste often drop the part of the name showing occupation and assume the family name of the person they serve. In some instances names are changed where they furnish impediments to securing suitable marriages for sons and daughters. The *Goigama* formerly named their children about 16 days after birth, while the other castes allowed 32 days to elapse. The wife keeps the *ge* name of her father after marriage. (Denham, pp. 178–179.)

In former times personal names were restricted to the particular castes, and this is still the practice in some parts of the Kandian area. Although today it cannot be said that a particular name belongs to a certain caste, the termination usually indicates whether the bearer of the name is of high or low caste. Modes of salutation vary greatly with the caste and rank of the addressee. Terms of affection and endearment are often applied to persons of low caste, such as "uncle" and "aunt" when addressing members of the Washerman caste or "boss" in addressing a Carpenter caste member. (Denham, 1912; Alwis, 1856–58; Hocart, 1938.)

In the earlier days a caste consisted of a group of clans, each clan claiming descent from a common ancestor from whom it took its name. Its name might also be taken from the office he held or from the village whence he came. Hereditary surnames were given to chiefs and the clan name dropped. During the Portuguese ascendancy European surnames were adopted by converts to Roman Catholicism. (A. A. Perera, 1917, p. 26.)

AGRICULTURISTS, OR CULTIVATORS

The *Goigama*, or *Vellala*, the great cultivating caste of the Sinhalese, is given the following synonyms by Upham (1883, pp. 338–339): *Khetta* or *Kettau Jiewakayo*, livers by the field; *Kassakayo*, plowers of

the land; *Goyankaranno*, sowers or cultivators of rice; *Goiyo* or *Goigama Etto*, cultivators (or rice village people); *Goi Bamuno* or cultivating Brahmans; *Goikulayo* or of the cultivating caste; and *Handuruvo* or *Sandurowo*, sons of peace. The plowshare was their flag symbol (see E. W. Perera, p. 23).

This caste was subdivided into a considerable number of subgroups in terms of occupations and hereditary or ceremonial rank and the upper divisions did not formerly intermarry freely with the lower. The upper rank of *Goigama* could marry a *Pattea* (Shepherd) woman, but no man of the latter could dare present openly a claim to a bride in the upper ranks. (Pridham, 1849, vol. 1, p. 235.)

The *Hondrews* (*Hamaduruwo*), or Gentlemen, were distinguished by their names and their clothing. The men wore the cloth halfway down the legs and the women to the heels with one end flung over the shoulder. The *Hondrew* head-covering consisted of two flaps tied over the top of the crown. Their caps were always white or blue and those of inferiors of different colors. (Pridham, *loc. cit.*) The *Hondrew* chiefs and nobles performed various honorary services for the king and paid homage on New Year's Day, presenting a roll of betel leaves. (A. A. Perera, 1903, pp. 336–337.)

Goigama tenants carried messages, supplied betel and areca, kept guard, provided for strangers or visitors, attended during domestic ceremonies, and when necessary cooked provisions or provided buffalo for plowing (*ibid.*).

The duties of the various classes of *Goigama* tenant were highly specialized and carefully delineated. For example, the *Atapattu-wasama*, or messenger class, carried messages, kept guard over treasures, temples, and chiefs' houses, carried state umbrellas in procession, watched threshing floors, and accompanied proprietors on journeys. (Coomaraswamy, p. 24.)

The *Dunukarawasama*, or military class of archers, held land in return for services in carrying letters and messages, keeping guard at the house of the proprietors, watching the threshing floor, and accompanying the proprietor on journeys of state bearing the lance. (A. A. Perera, 1917, App. p. vi.)

The *Dalumura-Panguwa* performed the service of supplying weekly or fortnightly and at festivals a certain quantity of betel leaves for consumption by the officers and priests. This service was of great importance at the royal court, and the king had plantations of betel in different parts of the country complete with staffs of officers, gardeners, and carriers. Later under British rule the tenants of this class supplied betel to proprietors for consumption at home and while on journeys. In some instances a quantity of areca nuts also was furnished. (*Ibid.*, p. iv.)

The *Ganwasama* were a superior class of tenants in the village who supplied the proprietor with subordinate village officials such as *vidanes* (headmen), *lekamas* (writers) and *kankanamas* (overseers). This class was often of the same social standing as the proprietor and sometimes related to him. They were often the wealthiest people in the village, holding the most fertile lands. They had to make heavy contributions to the proprietors and their retinues. This class also provided sustenance and shelter for visitors and strangers. The superintendence of building work at the proprietor's house and the function of presiding at festivals also devolved upon them. The *Ganwasama* accompanied the proprietor on journeys and took the lead in the annual presentation of the tenants before the proprietor. (*Ibid.*, p. vii; Coomaraswamy, p. 24.)

The *Hewawasama* was a military class whose services included carrying messages and umbrellas, keeping guard, and attending at funerals. They also furnished subordinate officials. This class had charge of proprietors' houses, of cleaning and repairing the premises, and of supplying flowers to the temples. (Perera, p. xii; Coomaraswamy, p. 25.)

The *Lekam Panguwa* tenants did duty as writers to the proprietors, superintended working parties and harvesting operations, and appeared before the proprietor at the

annual presentation of the tenants. They also attended the proprietor on journeys, cared for him when he was sick, and helped guard his house. They also occasionally assumed the duty of headmen, but their regular duty was to keep accounts of things received and issued and of arranging and supervising services of tenants. (Perera, p. xii.)

The *Nilawasama* class supplied temples with vegetables for festivals and performed a vast array of domestic duties of outdoor type. They supplied fuel and water to the kitchen and bath, pounded paddy, extracted oil from nuts, repaired walls and floors, transported timber, prepared clay, supplied firewood for brick and tile kilns, blew bellows for the smith and supplied him with charcoal for the forge, broke up limestone, cut banks and ditches, put up fences, cleared gardens, swept out courtyards and compounds, joined in all agricultural operations in gardens and fields such as planting and harvesting, tied straw and assisted in thatching, carried palanquins or baggage on journeys, bore objects in processions, and served in the ceremonies at weddings, funerals, *Yak* (Devil Worship) and *Bali* (Planet Worship) rites. (Perera, pp. xv–xvi.)

Nilawasama tenants were of low status for the most part, and their yearly dues consisted of vegetables and contributions of uncooked food. Beside working for the proprietor they also performed services for headmen and for other classes working in the fields for a few days and carrying their baggage on journeys. Some were placed in charge of temple cattle and provided fresh milk at ceremonies and at New Year's. (Perera, pp. xv–xvi.)

The *Manana* tenants measured out paddy given to be pounded as well as paddy brought in from the fields. This office came to be held by a low class of *Goigamas* and has been equated with those who put up privies, put mud on walls, or carry palanquins, baggage, and torches. They served as messengers for the headmen of the village, watched at the threshing floor, took care of buffalo brought in for plowing or threshing and assisted in the collection of dues. (Perera p. xiii.)

The *Nillemakareyca* or *Pattea* people were not very numerous since their occupation was stock-keeping, and large pasture areas were few in old Ceylon. They were also cultivators and paid taxes in rice, milk, and ghee. They were of inferior status. (Pridham, vol. 1, p. 236.)

The Veddas (*Dodda veddas*) are of *Goigama* caste. They were called *Wanacharakayo*, wild men or men of the desert, and *Weddo* or tormentors because although they fled to the jungle to escape oppression or being tormented they killed animals for a living there. They lived in *Wedigama* villages and were held in low status because of their taking animal life. Under the Kandian regime they were required to furnish the king with wild game. (Upham, vol. 3, p. 346; Pridham, vol. 1, p. 240.)

There were several minor groups of *Goigamas* such as the *Gauraykawallu* or village watchmen and the *Kappuwo* or temple watchmen, the *Hunu gambadu* or coolie peasants who foddered and took care of cattle, and the *Malcaruwo* or flower gardeners. The last were sometimes called *Mawlacawrayo*, or chain makers, because they made garlands or chains of flowers. (Upham, vol. 3, pp. 349–350; Pridham, vol. 1, p. 241.)

The dress of the *Goigama* men consisted of a *topetti*, a long cloth of two breadths about the loins and extending as far down as the ankle. A cloth about the head was folded like a turban leaving the top of the head exposed. On state occasions a short jacket was worn except in temples. (Pridham, vol. 1, p. 235.)

The dress of the *Goigama* women was a long cloth of a single breadth called a *hala* wrapped around the loins and cast over the left shoulder. On state occasions a jacket was worn with a kind of ruff hanging from the neck over the shoulders. Rings, silver or crystal bangles, and ear ornaments also were worn. (Pridham, *ibid.*; Bennett, pp. 98–99.)

Rank with the *goigamas* was indicated by the rich quality and quantity of apparel rather than by fashion. The highest rank wore the finest embroidered muslin set off by a succession of topetties, often six or

eight in number, with the shoulders unnaturally widened by a jacket stuffed and padded to correspond with the girth of the hips. (*Ibid.*)

According to Coomaraswamy (p. 22) the *Goigama* constitute about 90 percent of the Sinhalese population. This seems to be too high when other evidence is taken into account. The minor groups such as the Veddas have always been small in modern times. The Veddas numbered 2,030 in 1871, 5,332 in 1911, and 4,510 in 1921 (Census of Ceylon).

In the "Hue and Cry" statistics 780 *Goigama* were found in the following occupations: cultivators (317), coolies (266), carters (49), miners (43), domestic servants (27), traders (21), masons (12), carpenters (10), cooks (10), clerks (9), boatmen (6), breadsellers (5), and peons (5). According to the same source the chief crimes charged to 401 *Goigama* castemen were theft (especially of cattle) and housebreaking (234), causing hurt (55), robbery (34), criminal breach of trust (27), habitual criminal (18), assault (9), criminal misappropriation (8), forgery (6), arson (5), and cheating (5).

There are almost a score of divisions recorded for the *Goigama*. They are as follows: (1) Axmen and *Porakara* or *Porawakkarayo* and *Kunammaduvegamayo* (Niti Nighanduwa); (2) Bali ceremonialists, *Balibatgamayo* (Niti Nighanduwa); (3) Betel-furnishers, *Dalaemurecarao* (Valentyn); (4) Bridge-builders, *Waddewassam Karayo* (De Saram); (5) Cattle-tenders, *Pattiwalayao* (Armour) or *Pattiwala aya* (Niti Nighanduwa); (6) Cultivators, *Ratte etto* or *Wellales* (Armour) and *Gombaducarao* (Valentyn); (7) Elephant-keepers, *Etwalapannikkayo* (Niti Nighanduwa); (8) Flower-growers, *Malkaruvo*, Garland-makers (Niti Nighanduwa) or *Mallaccarao* (Valentyn); (9) Gem-collectors, *Diegaranno* collected from stream beds and *Goddegaranno* collected from the soil (Valentyn); (10) Hunters, *Weddo* (Armour) or *Wediwanse* (Niti Nighanduwa) or divided into *Wanneweddas* and *Dadaweddas* (Valentyn); (11) Milk-suppliers, *Hunkicarao* (Valentyn); (12) Nobility and Gentlemen are divided into *Handuruwo* (Armour), *Bandaarawaliya* (Armour) or *Bandares* or *Adassing* (Dukes, Princes, etc., of Royal Family—Upham), *Appuhamies* (De Saram), *Safframadoo Appuhamies* (De Saram), *Mantriunu* (Privy councilors—Upham), *Mandelliperu* (Military officials and *modeliars, adiyars, dessaves*—Upham), *Radalakamperuwa* and *Mudeliperuwa* (Armour and Niti Nighanduwa), *Paindi Peruwa* or *Rate Etto* (Niti Nighanduwa); (13) Outcastes from *Goigama*, *Gattaroo* (Armour) or *Gattaru* (Niti Nighanduwa); (14) Seeders, *Batgamwella etto* (Valentyn); (15) Shepherds, *Nilemakkareyo* (Armour) or *Nillamakkarayo* (Niti Nighanduwa); (16) Soldiers, *Hewapannay* (Soldiers and lascoreens—De Saram) or *Gowiperu* (Military and agricultural laborers—Upham); (17) Soothsayers and Jugglers, *Wiramestaragolla* (Niti Nighanduwa); (18) Tamil Fishermen, *Timbillo* (Armour) or *Tibiblo* (Niti Nighanduwa); (19) miscellaneous groups such as *Cariawassin* or *Mayorals* (De Saram), *Kuttanwala etto* (Niti Nighanduwa), *Weeramesseroo* or *Gooroowo* (Armour) and *Kammalhandooroowo* or *Wagayo* (Armour).

BARBERS

The Barber caste was always a small one, since the Sinhalese usually shaved themselves. However, the royal court at Kandy required some barbers. The following synonyms are given for this caste by Upham (vol. 3, p. 343): *Cappakayo*, or cutters; *Nahapikayo*, or comforters; *Karranawiyo*, or razor users; *Pannikkiyo*, which means leaf or foliage cutters; *Ambetteo* or *Embettayo*, i.e., near approachers or livers near in reference to their position as ministers of the royal cabinet and proximity to the king's person.

As a rule barbers shaved only the higher castes. The Barber paid a tax in money for his land and was liable to service as a baggage porter. The annual ceremony of feigned shaving of an image of the Buddha in the Temple at Kandy was performed by a member of this caste with the aid of a looking glass so that he might not desecrate the image by looking at it directly. The manorial lord was always attended by his barber. Barbers had the privilege of wearing

white linen under the Kandian monarchy. Both men and women of this caste could wear doublets but could not sit on stools. Upper-caste Washermen washed for them but would not dine with them. (Pridham, vol. 1, p. 238; Davy, p. 125.) Virchow says that the Barbers and *Hanomoreyo* (betel box-makers of Uva) were even lower in status than *Rodiyas*.

The *vidahn mohandiram*, or caste headman, wore a cloth or linen coat with silk buttons and loops; a sword hilt and scabbard of silver, the latter with two plates of tortoise shell on it; and a belt of colored ribbon embroidered with flowers of silver thread. (Bennett, p. 100.)

Sinhalese Barbers numbered 260 in 1881; 1,287 in 1891; and 1,327 in 1901, according to the Census Report.

BASKET-MAKERS

The Basket-maker caste was apparently a small one. Upham (vol. 3, pp. 348–349) gives the following names for this group: *Sinnawo*, or cutters, referring to their cutting and bringing home of their materials; *Hadayo*, or plaiters, because of their weaving or plaiting of materials; *Welwaduwo*, or rod-carpenters in reference to their use of rods to manufacture articles; and *Cooloopotto*, or peeling winnower makers, because they made winnowers by peeling bamboo cane and reeds. More commonly this group was called *Handee*, or *Handi*. They were required to furnish the stores of the Kandian monarch with baskets and winnows, and were thought to be a beggar caste by some writers. (Pridham, vol. 1, p. 348–349; Davy, p. 129.)

BRAHMANS AND OTHER VARNAS

There are apparently no Brahmans among the Sinhalese of today. Traditionally this caste, however, was present among them and constituted the next to the highest, if not the highest, of all the castes. The Kings, or Rajahs, were members of the *Kshatria Varna* and were the landlords of Ceylon. Regarding the third major division, the *Wysya* (Vaishya) *Varna*, there is some confusion. Buyers and sellers as well as makers of merchandise were once classed as *Wysyayo* and were divided into three categories: (1) dealers or merchandisers, (2) cattle tenders, and (3) tillers of the soil. The merchants, or *Welindo*, seem to have disappeared from the Sinhalese system and their place was taken by the Tamil Chittys and Moslems.

The *Goigama* claimed descent from the *Vaishyas* and held themselves aloof from all the lower groups who were called *Sudras*. Members of other castes assert that the *Goigamas* were originally *Sudras* rather than *Vaishyas*. *Karawe* caste members have laid claim to *Kshatriya* status.

The different divisions of the *Kshoodra Wanse*, or *Sudras*, were organized by the government for its own use and for the benefit of the ruling caste of the *Goigama*. Under the Kandian monarchy each caste had specific duties to pay and certain services to perform and were responsible to officers appointed by the king. Armour lists 18 *Wanam*, or occupations, that in their names were reminiscent of the 18 guilds of the Buddhist Period and the 18 servants of the Tamils. Bennett speaks of the five performers of service, namely, carpenters, weavers, washermen, barbers, and sandal-makers. This recalls the fivefold division of servants into smiths, tailors, washers, barbers, and leather-workers given in the *Janavamsa*. Arthur Perera (1917, pp. 26–27) divides the groups below *Goigamas* into *Naides* (smiths and allied groups), *Durayas* (servants), and professional or service groups including barbers and washers. The *Pancha-chandalo*, or five men of degraded caste, were among the Sinhalese traditionally the washermen, potters, barbers, silversmiths, and tailors. In addition there is the tradition of the *Pas kula* or five tribes (five handicraft castes or traders), viz.: carpenters, weavers, washers, barbers, and shoemakers.

CINNAMON-PEELERS

The following synonyms are given by Upham (vol. 3, pp. 339–340) for this caste: *Paisakara Brahmanayo*, or gold and silver thread weaving Brahmans; *Tantavayo*, or yard-stretching weavers (because they stretched and ordered their warp and wove

it with weft); *Paisacawrayo*, or *Paihairo*, i.e., weavers of gold and silver thread; *Salagamayo*, or *Halagamayo*, i.e., people who inhabit the large hall village (referring to Chilaw on the west coast whose older name was Salawa); and *Mahabadde*, the great rent, referring to cinnamon as the principal source of revenue (they were also called Chalias, or people of Chilaw, sometimes abbreviated to Hali); and *Pesa karayan*, or makers of cloth strainers to filter water.

According to tradition the king of Dambalewa in the Seven Corles, called Walthimi Buwanaika Rajah, six or seven hundred years ago caused a colony of Paisekara weavers to be brought from India to establish a cloth manufactory at Chilaw. Special apartments or large halls were reserved for their use. (Upham, *loc. cit.*; Johnson, pp. 44–84; E. W. Perera, pp. 20–21.)

In later times, with the coming of the Portuguese, these weavers took up cinnamon-peeling as a major occupation. Their numbers were always small and insignificant in the highland area of Kandy, but in the maritime provinces they were numerous. Many have become wealthy and ambitious under European rule. A small branch called the *Velledurai* weavers were described as living chiefly in the barren districts of Neurakalalawa in the north. On the coast the Chalias of today are chiefly clustered about Galle and Chilaw. (Pridham, vol. 1, p. 239; Davy, p. 126.)

The Washermen for the Chalias were called *Hinnevo*. Under the older regime the Cinnamon-peeler caste was not allowed to wear white linen. For their lands they were required to pay a money tax and were liable to be employed in the royal kitchens to fetch firewood, clean *chatties* or pots, and carry provisions. They also served as the bodyguards of the lords, especially on journeys. De Saram (*in* Hayley, p. 101) divided the Chalias into four occupational subcastes—*Paniwidacaraya*, headmen or messengers; *Hewapanne*, or lascoreen warriors; *Cooroondo Caraya*, or cinnamon-peelers; and *Oliyakaraya*, or palanquin-bearers.

The services required of the Chalias of the Seven Corles, a total of about 500 families, included the furnishing of the king's stores with an annual quota of salt fish. They could not wear caps or cloths reaching much below the knees, and the dress of the women was similar to that of the Potter caste.

According to the "Hue and Cry" data the chief occupations of 60 Cinnamon-peelers, or *Halagamas*, in 1905–07 were—cooks 27, cinnamon-peelers 10, carters 8, traders 6, cultivators 5, and carpenters 4. The occupations of 14 Salagama Cinnamon-peelers were—cultivators 7, cooks 4, and cinnamon peelers 3.

Under the European rule in the maritime provinces the Cinnamon-peelers came under a special jurisdiction and ultimately felt powerful enough to dispute precedence with the Fisherman caste. In 1733 they went on a strike against the Dutch Government because of the poor working conditions and income derived for their labors. Their disabilities and the degraded state of the caste generally caused many of them to flee into the highlands. The remainder were able to obtain much more favorable terms with the Dutch cinnamon traders. Although the women were forbidden to do so, the men might marry into the caste next below them. (Pridham, vol. 1, p. 239, footnote; Tennent, vol. 2, pp. 123–124, footnote, 157.)

There were, according to the Census, 1,773 Sinhalese cinnamon-peelers by occupation in 1881, 7,899 in 1891, and 15,222 in 1901.

DANCERS

The masked Dancers were a small caste. Their principal designation was *Oliyo*, which is interpreted to mean disguised actor or comedian. According to Upham (vol. 3, p. 350) the term *Uhuliyo* was also applied to this group because they appeared with masked faces and made gestures. To exorcise the Spirits of Poverty, the *Gara Yakku*, the *Oli* performed a special all-day dance called *Gara Yakuma*, wearing special masks. One of the major functions of this group was to carry the large effigies of the *Assooriah* demons in processions at the annual festivals. They are thought to have manufactured these effigies (Pridham, vol.

1, p. 241). Denham (p. 190) gives the honorific term *Bali-eduro*, a teacher of Bali ceremonies, and *Balitiyanna*, one who molds Bali images, to members of this group. Davy (p. 129) terms them *Olee*.

In older days the *Oli* provided the lords of the manors with oil for burning at night and swept out the premises by day. They also assisted in the care of the elephants. They were not allowed the honor of white linen and the *Gangavo* Caste washed for them. (A. A. Perera, 1903, p. 337.)

According to the census, there were 1,520 Sinhalese Devil-dancers in 1881, 3,278 in 1891, and 5,423 in 1901. Devil-dancers might also include Tomtom-beaters.

DRUMMERS AND WEAVERS

The chief synonyms for the Tomtom-beater caste or Weavers were, according to Upham (vol. 3, pp. 346–347): *Atodyawasakayo*, after Atodya a royal minister who first appointed them to this duty and who himself made and played on the first timbrel or drum with one head, which was later called by his name; *Berawayo*, because they beat the *baira*, or tomtom; *Ganitayo*, or counters (calculators), because they were astrologers and calculators of the motions of the planets. Denham (p. 190) asserts that the term *Panikkiya*, which referred to a headman of this caste, was frequently employed as an honorific title to ordinary members as was *Nekatiya*, astrologer, because of the knowledge possessed by this caste on the subject of the stars. Other terms employed were *Tablinjenos* and *Wajjankarayo*, the latter meaning "tomtom beaters." In general a considerable variety of names were applied to this *Berawayo* caste in terms of the various functions it performed.

According to Valentyn (*in* Philalethes, p. 330) the *Berawayo* had lime-burner, dancer, grass-mower, and deccum-carao (annual poll-tax payers) divisions, each of which had its own superintendents or *manquedams* whom they especially designated as *ulewalia*.

The *Berawayo* did not eat with low castes but could not use white linen, and the *Pally* caste washed for them. On the whole *Berawayo* were numerous and well distributed through the villages. Their major employment was as weavers of coarse native cloth, but they were noted also as musicians and as participants in festivals or rites, beating the drum and giving notice of such events. (Coomaraswamy, p. 232; Parker, 1917, pp. 28–29.) They were experts at rhythm and melody and were devoted also to duties as watchers at temples, sweeping and cleaning temple premises, gathering flowers for temple offerings, and fetching water for the temple. Their services were necessary at weddings, funerals, Yak (Devil-worship) and Bali (Planet-worship) ceremonies, and on state occasions. They paid a tax in money to the Kandian king. In addition they supplied the royal store monthly with vegetables and provided the wooden gutters of the *Ketoolga* tree. In some districts an annual quantity of cloth was provided by them to the manorial lord.

Particular families among the *Berawayo* had lands for their services as pipers, dancers, and players at the great festivals. Temple lands were cultivated by them on the same terms. They were allowed to eat and carry away all victuals offered to the gods and were also reputed to eat beef. The members of the caste who beat the tomtom were called *Tammattankarayo*, while those who wove cloth primarily were called *Dawulkararayo*. Another group was the *Bali-eduro*, who made the clay images for and danced at Bali ceremonies to propitiate the planets. A performer of devil ceremonies in this caste was called *Yakdessa*. (A. A. Perera, 1917, App.; Coomaraswamy, p. 148; Davy, pp. 128–129; Pridham, pp. 240–241.)

The census enumerated 823 Sinhalese Tomtom-beaters in 1881, 2,318 in 1891, and 1,649 in 1901.

ELEPHANT-CATCHERS

The *Weenawo* were a caste devoted to the function of elephant-snaring. They followed the track of elephants and drove them into snares or put them to death in cases of peril or emergency. Special washermen washed for them but would not eat

with them. They did not have the privilege of wearing white linen. (Valentyn, *in* Philalethes, p. 329.)

FISHERS

Upham (vol. 3, pp. 345–346) gives the following synonyms for the *Carawo*, or Fisher, caste: *Wagurikayo*, i.e., workers or dealers in the water, referring to their habit of wading and working in the water; *Jawlikayo*, or workers with nets; *Kay-wattayo*, or surrounders of water, because in fishing they surround a spot in the water; *Kaywulo* of *Kaywattayo*, which means those who dwell near the shore; and *Carawo*, which means "shore people" or dwellers near the shore.

The Fisher caste was evidently divided into a considerable number of sub-groups, and, according to Valentyn (*in* Philalethes, pp. 325–327) the lower ranks were kept separate from the rest. The higher ranks of Fishers participated in the privileges of the *Vellalas* or *Goigama*, and higher washerman were under obligation to wash their clothes. On the great festive occasions the higher Fishers could spread a white cloth on which they could dine and could cover their stools with white cloth also. Their dwelling could be decorated likewise, and they could carry a torch in their processions. They displayed a white flag with the device of a fish or elephant in the center. (Fonseka, pp. 1–11; E. W. Perera, pp. 21–22.) In addition they could carry an umbrella of the *tallipot* palm and in their own lands could have a white calico cloth spread beneath their feet. They possessed military offices and some were appointed to the office of *adigar* by the king. They might be carried in palanquins with drums beat before them on the road in ceremonial parades. (Valentyn, *op. cit.*; Pridham, vol. 1, pp. 236–237.)

The Fishers were members of the *Madege* Department in the government along with the Moors, or Moslems, whose reputation and status they shared. (Davy, pp. 122–123; Pridham, vol. 1, p. 237.) The *Modeliar* and *Mahavidahn Modeliars* of this caste wore a silk or cloth coat with silver buttons and loops; sword hilt and scabbard of silver and with eyes and tongue of the lion's head made of gold, the belt of gold or silver lace but not spangled. The headmen of the *Chandoos*, or Toddy-drawers, shared this costume. (Bennett, p. 99.)

The duties of the *Karawe* tenants included the transportation of the paddy from the fields to the granary and attendance to the carriage department already noted. They also provided fish for the kitchen of the landlord. (A. A. Perera, p. 336.)

Dharmaratne (pp. 27, 40, etc.) divides the Sinhalese castes into two geographical groups, namely (1) Coastal or Lowland *Karawe*, together with their ancient allies the "poetic" *Durawe*, and the "witty" *Chalias*, and (2) Kandyans who comprised *Goigamas*, *Navandannas*, *Badahelas*, and *Wahumpuras*. Further, he would add the Tamil-speaking "Karawe" of the North and east coasts to the Sinhalese *Karawe* caste. Three-fourths of the *Karawe*, he asserts, are today the owners of extensive lands, planters, traders, merchants, etc., and the remaining one-fourth are carpenters, coopers, builders, boatmen, carters, and coolies, with only a scant one-sixteenth engaged in fishing.

In the recent period the *Karawe* have engaged in a vigorous rivalry with the *Goigama* for social position. The period of Portuguese rule was marked by extensive conversion of the *Karawe* to Roman Catholic faith. For this reason the Protestant Dutch favored the *Goigama* over the *Karawe*, it has been asserted. (*Ibid.*)

Under English rule the *Karawe* prospered once more, and their acquisition of new wealth led to the demand early in the twentieth century for better representation in the Legislative Council of Ceylon. Hitherto the *Goigama* had monopolized the position of representing Sinhalese interests on the council. From this situation it can be seen that the caste spirit is still very much alive among the Sinhalese even at the present time, in spite of the decline of the old occupational sanctions. (Encyclopedia Britannica.)

The "Hue and Cry" gives the following occupations for 112 *Karawe* members listed: coolies 51, cultivators 18, carpenters 16, traders 9, fishermen 9, and carters 9.

According to the census the Sinhalese fishermen numbered 10,414 in 1881, 35,367 in 1891, and 38,504 in 1901. In the "Hue and Cry" records of crimes charged to 149 *Karawe*, we find the following figures: theft and housebreaking 67, causing hurt 32, criminal breach of trust 15, robbery 14, murder 9, assault 6, and escaping custody 6.

The Fisher caste is subdivided into about 17 groups, as follows: (1) Animal-trap-makers, *Ugulwadi* (Bennett and Pridham); (2) Archers, *Dunuwaayeli* (Bennett and Pridham); (3) Ax fishers or Timber-fellers, *Porawakkara Karaway* (De Saram); (4) Bird-catchers, *Paksi* or *Pakai wadi* (Bennett and Pridham); (5) Bird-snarers, *Williya* (Bennett and Pridham); (6) Boat-fishers or Skate fishers, *Oru Karaway* (De Saram) or *Moru-karawo* (Valentyn); (7) Crocodile-fishers, *Kayman wadi* (Bennett and Pridham); (8) Date-flower fishers, *Indimal Kewulu* (De Saram) or *Indimal-keulo* (line-makers and net-makers—Valentyn); (9) Executioners, *Wadekayo* (Bennett and Pridham); (10) Fishmongers, *Maswikunanno* (Bennett and Pridham); (11) Hook-and-line anglers, *Kaywulo* (Bennett and Pridham); (12) Madel-net fishers or red-sail fishers, *Madel Karaway* (De Saram) or *Kadul-karawo* (Valentyn); (13) Net fishers in the sea, *Muhududaye* or *Meehududaye wadi* (Bennett and Pridham) and *Baroodel Karaway* (De Saram) or *Barudel-karawo* (Fishers who do not use casting nets—Valentyn); (14) Rivermouth fishers, *Gode kewuloo* (Fishers from land—De Saram) or *Godo-keulo* (Valentyn); (15) Rod fishers with bamboo, *Dandoo Karaway* (De Saram) or *Dandukarawo* (Valentyn); (16) Tok fishers, *Tok Kewuloo* (De Saram) or *Tock-keulo* (Fishers in fresh water—Valentyn); and (17) Turtle- or Tortoise-fishers, *Kesbakaraway* (De Saram) or *Kespe-karawo* (Valentyn). According to De Saram numbers (3), (14), (16), and (8) were low in status and did not intermarry with the rest. Similarly, Valentyn lists (16), (14), and (8) as of low status and not intermarriageable with the others. There are some indications that (11) and (16) may be identical groups. There are also evidences of two distinct classifications, with Valentyn and De Saram agreeing fairly closely as against Bennett and Pridham.

GRASS-CUTTERS

The term *Pannayo* is generally applied to the Grass-cutter caste and is derived from the word *pan*, a name for a species of high grass that they cut. This caste is also called *Jana Capanno*, or grass-cutters, because they cut fodder for horses and gathered leaves and branches for elephants. (Upham, vol. 3, pp. 347–348.)

This was a numerous group, and the services they rendered in return for their land tenures included the care of the royal cattle, and elephants, and the horses, as well as the furnishing of vegetables for the king's stores every fortnight. (Pridham, vol. 1, p. 240; Davy, p. 127.)

They also wove grass mats (*peduru*) out of various grasses and palm leaves and manufactured baskets and betel pouches. They employed a grass knife making their baskets of cane or rattan (*Calamus roxburghi*) and dyeing them red. Mats were provided for royal use when required. (Coomaraswamy, p. 240; Pridham, vol. 1, p. 240.)

In 1881 the census recorded 104 grass cutters and in 1891 listed 918.

JAGGERY-MAKERS

The manufacturers of sugar from palm juices were quite a distinctive caste. According to Upham (vol. 3, p. 347) they are called *Kandey Etto*, or Kandians, because of their residence in the Kandian highlands; *Sangarammu*, or defender of the priests' gardens (also interpreted as cohabitors with sisters or with own blood); and *Sakuro* or *Pakuro*, stone-makers because of the hard cakes of sugar or jaggery they produced. Frequently heard in modern times are the terms *Hakuru* and *Wahumpura*, or cook. According to Denham (p. 189) the honorific terms *Devayo* and *Vahum purayo* applied to this caste means workers in the kitchen. They were also called by the euphemistic name of *Kande-minissa*, or hillmen, because they were located primarily in the highlands.

In general the duties of this caste included sugar-making, cookery, palanquin-bearing, domestic service of various kinds, baggage-carrying, and agricultural activities. They were required to attend the manorial lords on journeys and to carry the palanquins of female members of the proprietor's family. When not engaged in domestic duties they supplied jaggery and vegetables, attended agricultural duties, or carried baggage. One-half share of the toddy (*Kitulanda-Mure*) of all kitul palms tapped was due to the proprietor. The toddy was converted into sugar by the *Hakuru*. This caste furnished the *Goigama* with cooks and were a fairly numerous group. The *Hinnevo* washed for them and they were excluded from the use of white linen. (A. A. Perera, App. p. xxii, uses the name *Wahumpuraya* for them; see also Upham, vol. 3, p. 347; Pridham, vol. 1, pp. 239–240; Davy, p. 127.)

The Sinhalese jaggery-workers numbered 303 in 1881, 1,990 in 1891, and 12,413 in 1901. The chief *Hakuru* occupation in the "Hue and Cry" records was agriculture, while the chief *Wahumpura* pursuits were coolie labor and agriculture, with small numbers serving as carters and masons.

LEATHER-WORKERS

The Leather-workers (Tanners) and the Shoemakers appear to have been one and the same caste. Following Upham's account (vol. 3, p. 344), the principal terms employed for this group were *Chammakarayo* (Chamars?), i.e., skin dressers; *Rattakarayo*, i.e., carriage makers in reference to the manufacture of harness for chariots and carriages; *Samwaduwo*, or skin carpenters; and *Sammahanno*, or shoemakers. The common terms *Sommaru* and *Hommaru* were employed to designate leather-workers. According to Bennett (p. 365) this caste was one of the *Pass mehe Karayo* or five performers of services along with carpenters, weavers, washermen, and barbers. The standing of Leather-workers is fairly good among Sudra groups. The Janavamsa includes them as one of the five servants along with smiths, tailors, washers, and barbers.

LIME-BURNERS

The caste of Lime-burners has been designated by a variety of names. According to Upham's account (vol. 3, p. 347) the principal ones were *Chunna-karayo* (reducers to powder, i.e., by burning stones, shells, and trees), *Sunno*, and *Hunno*. Denham (p. 190) asserts that the *Hunno*, or Lime-burners, may be addressed as *Panividakaraya* or *Payunda*, literally a messenger. He believes that persons of this caste may have been formerly employed as messengers or that perhaps the term arose from a designation for a minor headman. The terms *Chunam* burner and *Chinambero* were also used for them. According to Bennett (p. 566) the *Hunno* or *Chunam* makers were of the *Tolil Karayo* or particular services, along with the Tailors, Cooks, Tom-tom-beaters, and Palanquin-bearers. In general, the Lime-burners were given a low status among the Sudra castes, and according to Davy they were rather few in numbers. (See also Pridham, vol. 1, p. 240.)

The headmen of the Lime-burners were called *Hunudewea* and usually were engaged in plastering walls or superintending others of their caste. In olden times these persons whitewashed the house of the manorial lord once or twice a week. They also furnished purified lime for chewing with the areca nut and betel leaf. The *Deccum carao* of this caste paid an annual poll tax to the Kandian king and were required to keep up the lime furnace, to supply fuel, and to attend until the process was finished. They did not have the privilege of wearing white linen, and the *Pallys* washed for them. The *Huno kattanno* were employed in felling trees in the woods and in providing fuel the lime kilns. (Upham, vol. 3, p. 347.)

According to the Ceylon census of occupations in 1881, there were 785 Sinhalese Lime-burners, in 1891 some 2,092, and 1901 about 870. The Lime-burners in the "Hue and Cry" records were primarily coolies and masons.

MAT-WEAVERS

The following terms are used for Mat-weavers, according to Upham (vol. 3, pp. 350–351): *Pannakarayo*, i.e., leaf-workers,

referring to the weaving of various kinds of leaves; *Cattakarayo*, i.e, workers in hard matter or wood, because they pound on tree fibers until these are reduced to a pulp or wooly substance, which they use to make mats; *Tinakarayo*, i.e., workers in grass, because they make some kinds of grass into mats, and this by a transposition of consonants becomes *Kinnaru*, grass-workers; and *Hainawalaya*, i.e., fringe-makers because some mats are made with fringed selvedges. According to Denham (p. 190) the honorific term *Karmantakaraya*, or workmen, was applied to this caste.

Under the Kandian regime the *Kinnaru* were not allowed to wear any head covering or handkerchief. They were required to pay a *deccum* or poll tax and in virtue of this were called *Hiene Jaty*. They were regarded as a very low caste and were rather small in numbers. Their function was to furnish the royal stores with ropes and rush mats. They also wove cane baskets, made fans for fanning corn, and manufactured lace bedsteads and stools. The Dumbara mats were made of *niyanda* fibers (bowstring hemp or *Sanseveria zeylanica*). (Pridham, vol. 1, p. 241; Coomaraswamy, p. 243, gives examples of their work songs; Valentyn, *in* Philalethes, p. 331, gives the term *Hiene Jaty;* Parker, 1917, p. 30; Parker, pp. 44–45, 563–566.)

The *Kinnaru* were considered semi-outcastes of slightly higher position than the *Rodias*. The men were forbidden to grow hair beyond their necks, and the females from wearing anything more than a narrow strip of cloth above the waist to cover their breasts. Mat-weavers were absolutely forbidden to enter temples or sacred enclosures. Like the *Rodias*, they had their own doctors, astrologers, soothsayers, and officials for demon ceremonies. (Parker, 1917, p. 30; A. A. Perera, p. 337.)

According to the census, Sinhalese caneworkers numbered 40 in 1881, 363 in 1891, and 438 in 1901.

(*To be concluded.*)

PALEOBOTANY.—*The Lower Eocene flora of southeastern North America.*[1]

EDWARD W. BERRY, Johns Hopkins University.

The Lower Eocene flora of southeastern North America comprises what is probably the most extensive fossil flora known from a single horizon in the world's Tertiary. It consists of several hundred nominal species —the precise number is immaterial, coming from 132 localities scattered along the shores of the Wilcox embayment through Alabama, Mississippi, Tennessee, Kentucky, Illinois, Arkansas, Louisiana, and Texas. I said the exact number of species is immaterial and I designated the species as nominal because it is a sound paleobotanical principle that in describing any fossil assemblage, where gradations between variants are not preserved or discovered, the new forms should be carefully described as new species. Hence, in all good paleontologic work there are probably more species described than actually existed. It is a sound method for a refined analysis to precede an attempted synthesis.

In a recent number of this JOURNAL[2] four Wilcox species and others inferentially are combined in three new generic assignments. It is these three generic assignments that invite comment. It is far from my purpose to become a knight errant in defense either of my own or of Knowlton's determinations, and I suspect that most readers have slight, if any, interest in the problem, but inasmuch as certain fundamental questions of paleobotanical practice are involved I feel constrained to review them. The first involves a form named *Diospyros asper* and thought to be a concrescent calyx compared with that of the living Asiatic *D. lanceolata* Roxburgh and with the fossil *D. rugosa* Saporta. Brown states in the article cited that these comparisons "fail to be convincing," and he therefore transfers the *Diospyros* to the genus *Fagus* and suggests that *Dryophyllum tennesseensis* Berry, a wide-

[1] Received December 20, 1944.

[2] BROWN, R. W. *Temperate species in the Eocene flora of the southeastern United States.* This JOURNAL 34: 349–351. 1944.

spread and very common leaf in the Wilcox, represents the leaves of this *Fagus*, of which the *Diospyros* calyces are regarded as the burs. Neither of these suggestions appeals to me as convincing, but there is more to be said.

These supposed burs have been found only at a single locality in Tennessee, and the *Dryophyllum* leaves have been found abundantly at 38 plant localities in five states and at none of these localities have the supposed burs been detected. Brown may, of course, be right. *Fagus* and the scarcely distinguishable *Nothofagus* are found in beds of this general age in various antipodeal regions and are considered to have had ancestors in the Northern Hemisphere, a fact that invalidates any argument against the presence of *Fagus* in as low a latitude as Tennessee at this time. By the same token it precludes the possibility of *Dryophyllum* representing a *Fagus* leaf.

Fagus burs are carried greater distances by natural means than are the leaves, and if, as Brown's hypothesis has it, this Wilcox material was brought into the basin of sedimentation from uplands with a cooler climate than that of the coastal Wilcox strip, these "burs" would be expected to be more abundant than the leaves. They are objects that would scarcely fail of detection, and it is strange that they have not been found at any of the 132 plant localities. Moreover, there is evidence that the eastern United States in Eocene time was a region of low relief and mature topography, and the fact that a considerable number of Wilcox species are identical with forms found in the contemporaneous lignites of Brandon, Vt., suggests that there was a general amelioration of climate, not only in eastern North America but in other parts of the world, notably shown in southern England.

The second species is called *Sassafras suspectum* and is based on certain leaves of *Sterculia wilcoxensis* found by me at Pine Top, Tenn. Although opinions may legitimately differ as to the propriety of associating the Pine Top specimens with the other occurrences of this species, I see no basis for referring them to *Sassafras*. Back in 1902 I made a study of the leaves of the living *Sassafras*[3] based on what was probably the largest collection ever made, and so there is presumably some actual basis for a judgment. The Wilcox leaves in question are too large to be those of a *Sassafras;* they have a different texture, which is hard to define in words but unmistakable to the trained observer; they do have the marginal hem in the sinuses, but this is also a feature of *Artocarpus* and other unrelated genera; they lack the characteristic venation of the basal triangle.

The chief point I want to make is that students should refrain from making changes unless they have facts as a basis rather than opinions. For example, I have long been of the opinion that some of the Wilcox leaves that are referred to *Ficus mississippiensis* really represent the genus *Hernandia*, but I certainly would not suggest such a change unless I had something more valid than a hunch with which to proceed, even though the genus *Ficus* is not very convincing. Another example is a statement (made, to be sure, when the author was inexperienced and afterward regretted by him) in the first volume of the late A. C. Seward's *Fossil plants*, where he implied that the paleobotanist could not differentiate between *Restio* (a monocotyledon), *Equisetum* (a lepidophyte), *Casuarina* (a dicotyledon), and *Ephedra* (a gymnosperm). The convergence in habit of these four is quite beside the point, since never in earth history have all four grown together or would they ever occur in the same deposit or ecological assemblage.

The third questionable proposal is to unite *Euonymus splendens* Berry and *Hicoria crescentia* Knowlton, to constitute a new species of *Staphylea*. The latter genus has trifoliate or pinnate leaves of moderate size with serrate margins and with the lateral leaflets sessile or subsessile. The fossils average 100 percent larger, are much more broadly ovate, and have acuminate tips and dentate margins. The petioles are long even in the minimum-sized specimens.

Waiving the question of whether the Wilcox leaves determined as *Hicoria cres-*

[3] Bot. Gaz. **34**: 426–450. 1902.

centia are identical with Knowlton's type from the West, they seem to me to differ from *Euonymus splendens*, and here again the *Euonymus* is abundant at 31 widely scattered localities at not one of which, or any other of the 132 plant localities, has a seed or the characteristic inflated fruits of *Staphylea* been found, the sort of a fruit admirably adapted for preservation had it been in existence anywhere in the general region.

In closing, may I again disclaim any feeling of proprietary interest or chivalry in defending the species discussed, but I do feel strongly that if science is not to become a joke its votaries must refrain from making changes in which opinions and not facts are allowed to assume so leading a role.

ENTOMOLOGY.—*Five new flea beetles from the West Indies.*[1] DORIS H. BLAKE. (Communicated by S. F. BLAKE.)

The following species of flea beetles, with one exception, were collected by P. J. Darlington, Jr., and were found in unidentified material at the Museum of Comparative Zoology, Cambridge, Mass.

Genus **Hadropoda** Suffrian

Hadropoda albicincta n. sp.

Fig. 4

About 3 mm long, reddish brown with piceous head and prothorax and dark, somewhat metallic markings on elytra and body beneath; covered with golden appressed pubescence not concealing the dense punctation of the head and prothorax and large striate punctures of the elytra. Elytra considerably wider than prothorax and with numerous dark spots, the ones nearest the suture raised to form warty swellings, also a hump at the apical narrowing. Antennae short, with greatly enlarged apical joints, fifth and sixth conspicuously white.

Head with interocular space more than half its width, piceous, densely and roughly punctate, with fine, short, appressed pubescence; frontal tubercles not very distinct, interantennal area not produced, lower front short. Antennae extending below humeri, the five apical joints darker and much wider than the basal ones, fifth and sixth joints conspicuously white. Prothorax with sides nearly straight, only slightly curved, with a nodule at each corner, densely punctate, covered with short, appressed pubescence, surface uneven with two sharp median elevations slightly before the middle and a shorter one below and between them; piceous with basal margin paler. Scutellum covered with golden pubescence. Elytra considerably wider than prothorax, fairly convex, deep reddish brown with a darker area at base and along the sides, and dark spots, the spots in the line nearest suture raised to form warty elevations, one on the callosity near the scutellum, one before and one after the middle, and a swollen area on the side at the apical narrowing, other less prominent spots along the sides, these not raised, about all these spots the pubescence arranged in a sort of circular whirl; a deep incurving sulcus running from within the humerus about the basal callosity nearly to the suture. Striate punctation large and deep. Body beneath deep reddish brown, shining, with pale pubescence, basal half of anterior femora pale, hind femora on back densely pubescent with dark median band. Anterior claws exceptionally large, and with a basal tooth; hind claws swollen. Length 3 mm, width 1.4 mm.

Type female, Mus. Comp. Zool. 26925.

Type locality.—Morne La Hotte, elevation 5,000–7,800 feet, Haiti, collected October 16, 17, 1934, by P. J. Darlington.

This species belongs to the same group as *Hadropoda barberi* and *hugonis*, the former from Puerto Rico, the latter from the Dominican Republic. Together they form a group that stands a little apart in the genus and resembles in many ways the species of the North American genus *Distigmoptera*. *H. albicincta* closely resembles *hugonis* but differs in having raised sutural margins and three warts as well as an apical tumidity on each elytron. Its elytral punctation is a little finer and the whole beetle slightly more slender. All three species are peculiar in having a white fifth, and in this species also a white sixth, antennal joint.

[1] Received January 5, 1945.

Genus **Oedionychis** Latreille

Oedionychis pseudothoracica, n. sp.

Fig. 5

About 6 mm long, oval, not very shiny, densely and coarsely punctate; head, prothorax, abdomen, coxae, and middle of breast yellow, antennae, legs, and rest of undersurface and five spots on pronotum dark brown, elytra blue-violet.

Head densely and rugosely punctate, the tubercles distinct, area between antennae slightly produced; interocular space approximately half the width of head; yellow-brown with dark mouthparts, slightly darkened tubercles, a spot on occiput and margin about eyes darker. Antennae rather heavy, extending to the middle of elytra, entirely dark brown, joints 3, 4, and 5 long and about equal. Prothorax at base twice as wide as long, narrowed anteriorly with the explanate margin becoming wider and slightly produced; disk covered with coarse and moderately dense punctures, yellow with five piceous spots. Scutellum black and shiny. Elytra smoothly convex, slightly wider posteriorly, with a narrow margin; intrahumeral depression short and not marked, sutural edges smooth, a little raised, surface more densely punctate than prothorax, deep violet-blue. Body beneath very sparsely pubescent, legs and metasternum shining with a faint metallic lustre, prosternum, middle of metasternum, coxae and abdomen pale. Length 5.7 mm, width 3 mm.

Type male, U.S.N.M. 57228.

Type locality.—Camagüey, Cuba, collected July 30, 1923, by J. Acuña.

Superfically this species resembles the North American *Oedionychis thoracica* Fabricius in markings and coloration. It belongs, however, to the group with the front of the head produced and the eyes rather closely set. It also has fewer pronotal spots than are found in *O. thoracica.*

Genus **Pseudoepitrix** Jacoby

Pseudoepitrix tetraspilota, n. sp.

Fig. 1

About 2.5 mm long, shining, reddish brown with four darker brown elytral spots, two at base and two in middle, and a dark abdomen; the striate elytral punctures distinct to the apex.

Head with interocular space half its width, frontal tubercles not distinctly marked, a depression behind running up to fovea by the eye, lower front of head long and gradually narrowing to labrum, distance from top of labrum to antennal sockets approximately equal to width between the eyes; occiput alutaceous and with a circle of fine punctures in the middle; head reddish brown, a little darker on top. Antennae extending to the middle of the elytra, gradually deepening in color, fifth joint long. Prothorax about a fourth wider than long, widest anteriorly, narrowed slightly to a prominent basal nodule, sides straight; basal margin somewhat sinuate; disk with a deep basal sulcus, punctation moderately dense and distinct. Scutellum deep reddish brown. Elytra shining, a distinct callosity at base near the suture and a well marked intrahumeral depression extending around and below it; on this callosity a deepening in coloration, a similar dark area in the middle of each elytron, these dark areas more or less conspicuous in four of the five specimens examined, in one only traces of the spots. Striate punctures distinct to the apex. Body beneath polished yellow brown, the abdomen, except for the pale tip, deep reddish brown. Length 2.3–2.6 mm, width 1.2–1.3 mm.

Type male, Mus. Comp. Zool. 26922. Four paratypes, two males, two females, a pair of these in National collection, U.S.N.M. 57229.

Type locality.—Pico Turquino, 5,000–6,000 feet elevation, Cuba, collected in June 1936 by P. J. Darlington.

This is the first species of the genus to be described from Cuba and the first spotted species known in the genus.

Pseudoepitrix longicornis, n. sp.

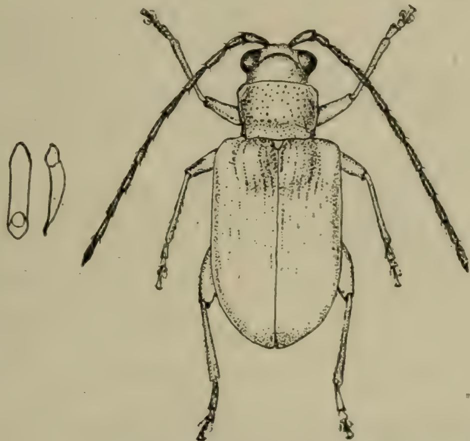
Fig. 3

About 2 mm long, shining, pale yellow-brown with slightly darker head and antennae, antennae in male approximately equal to length of beetle; elytral striae poorly marked toward apex of elytra.

Head with interocular space a little more than half width of head, lower front tapering, giving head a triangular shape in front, occiput alutaceous, very finely punctate on vertex, a depressed line running behind tubercles to fovea at margin of eyes. Antennae very long,

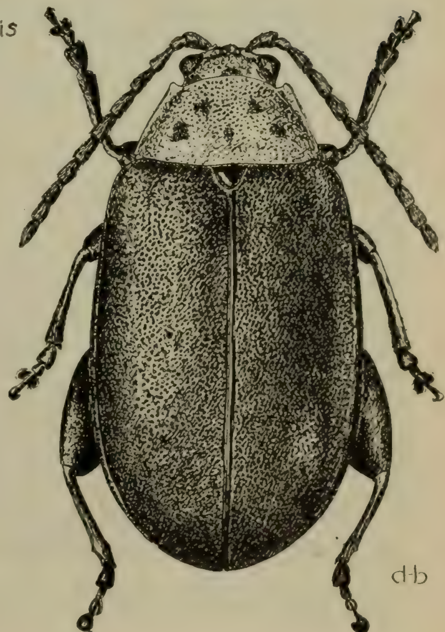
1. Pseudoepitrix tetraspilota

2. Pseudoepitrix darlingtoni



3. Pseudoepitrix longicornis

4. Hadropoda albicincta



5. Oedionychis pseudothoracica

Figs. 1–5.—Five New Species of Flea Beetles.

in male equaling the length of the insect, not quite so long in female, reddish brown. Prothorax less than a fourth wider than long, with straight sides narrowing slightly toward basal sulcus, basal sulcus well marked, disk covered with moderately dense and distinct punctures. Scutellum pale. Elytra entirely pale, basal callosity well marked, elytral striae becoming very faint and indistinct at apex and on sides. Body beneath pale in all but one of the four specimens, in that one the abdomen deep reddish brown, very sparsely pubescent, shining. Length 2–2.2 mm; width 0.8–1 mm.

Type male and 3 paratypes, Mus. Comp. Zool. No. 26924. One paratype in National collection, U.S.N.M. 57230.

Type locality.—Mountains north of Imias, 3,000–4,000 feet altitude, eastern Oriente Province, Cuba, collected July 25–28, 1936, by P. J. Darlington.

This species is well distinguished by the unusually long antennae, which in the male equal the length of its body; in the female they are not quite so long. In addition, it is smaller than the two other species described here from Cuba, and the punctation is less marked at the apex.

Pseudoepitrix darlingtoni, n. sp.

Fig. 2

About 2.5 mm long, shining, yellow-brown, with the head sometimes reddish brown, elytral striation visible to the apex.

Head with interocular space a little more than half its width, the front not so long as in *P. tetraspilota*, frontal tubercles not very distinct, bounded behind by a depressed line extending to fovea by the eye; occiput alutaceous and finely punctate. Antennae pale, deepening in color to apex, extending a little beyond the middle of the elytra, fifth joint longest. Prothorax about a third wider than long with almost straight sides, narrowing slightly toward base, basal sulcus well marked, surface moderately densely and distinctly punctate. Scutellum pale. Elytra with callosity at base and a deep incurving intrahumeral depression running down around it; elytral striation stronger at base but visible to the apex; color entirely yellow brown. Body beneath entirely pale, shiny, very sparsely pubescent. Length 2.2–2.4 mm; width 1–1.1 mm.

Type male, Mus. Comp. Zool. 26923, and three paratypes, two of which, a male and female, in the National collection, U.S.N.M. 57231.

Type locality.—Pico Turquino, 3,000–6,000 feet altitude, Cuba, collected in June 1936 by P. J. Darlington.

This is a paler species than *P. tetraspilota* and without markings. The aedeagus is also more pointed. The thorax is more coarsely punctate than in *P. hispaniolae* Blake, and the aedeagus is distinguishable from those of *P. hoffmani* Bryant, *P. jamaicensis* Blake, and *P. hispaniolae.* All these species of *Pseudoepitrix* are very closely related, but those on each island appear distinct. In Cuba alone three species have been collected.

ZOOLOGY.—*New urocoptid mollusks from Mexico.*[1] PAUL BARTSCH, U. S. National Museum.

The United States National Museum recently received two collections of mollusks from Mexico representing several new species of the family Urocoptidae. One of these collections was made at Teotitlán del Camino, Oaxaca, by the indefatigable collector Miss Marie E. Bourgeois, whose endeavors in the past have yielded a considerable number of new species as well as information pertaining to the ecology and distribution of previously described forms. The second lot was collected by Ing. A. R. V. Arellano and his students of the Instituto Politécnico de México. They were obtained in the limestone hills 10–30 km north-northeast of Cadereyta, Querétaro, at an elevation of about 2,100 meters.

Genus **Holospira** Martens

Holospira teotitlana, n. sp.

Shell cylindroconic, varying in color from milk white to soiled white; aperture white. Nuclear whorls smooth. The postnuclear whorls are slightly rounded on the cylindric portion of the shell. The early postnuclear whorls are

[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 22, 1945.

marked by weak, closely spaced axial ribs, which become less well defined on the later turns where they are also a little more distantly spaced. On the last whorl they become heavier and even more distantly spaced. Base well rounded with a well-impressed umbilicus. Aperture subcircular with a slight angulation at the posterior angle. Peristome white and reflected. The columella is slender and hollow and bears a strong lamella on the middle in the penultimate turn, which is thick and rounded at its free edge. The parietal lamella is broad, concave on the outside, and slightly outward reflected. The basal lamella is less strongly developed than the parietal lamella and occupies the middle of the base. The labial lamella is poorly developed, consisting of a mere heavy thread. All three of these elements find their greatest expression in the penultimate turn, scarcely extending beyond this in either direction.

This species somewhat resembles *Holospira nelsoni* Pilsbry, from which it can be readily distinguished by its white aperture.

I am recognizing two subspecies.

Holospira teotitlana teotitlana, n. subsp.
Fig. 2

This subspecies differs from *Holospira teotitlana filia* in being smaller, more slender, and with the axial sculpture a little more pronounced.

The type, U.S.N.M. 431954, has 12.5 whorls and measures: Height, 17 mm; diameter, 5.5 mm. It and 27 additional specimens were collected by Miss Bourgeois under rocks of a small circular foothill at the foot of the higher sierra called Cerro Blanco or Cerro de Tizatepec at Teotitlán del Camino, Oaxaca. Seventeen topotypes are entered as U.S.N.M. 431955.

U.S.N.M. 431956 contains five specimens from a nearby locality, and five additional specimens from the same lot are in Miss Bourgeois's collection.

Holospira teotitlana filia, n. subsp.
Fig. 1

This subspecies is in every way larger than *Holospira teotitlana teotitlana*, with the axial sculpture less strongly pronounced.

The type, U.S.N.M. 431957, has 13.2 whorls and measures: Height, 19.4 mm; diameter, 6 mm. It and seven additional specimens were collected by Miss Bourgeois at the foot of another circular hill near the village of Ignacio Mejia, Cerro de Tizatepec, State of Oaxaca, which is 10 km distant from the type locality of *Holospira teotitlana teotitlana*. Four of seven

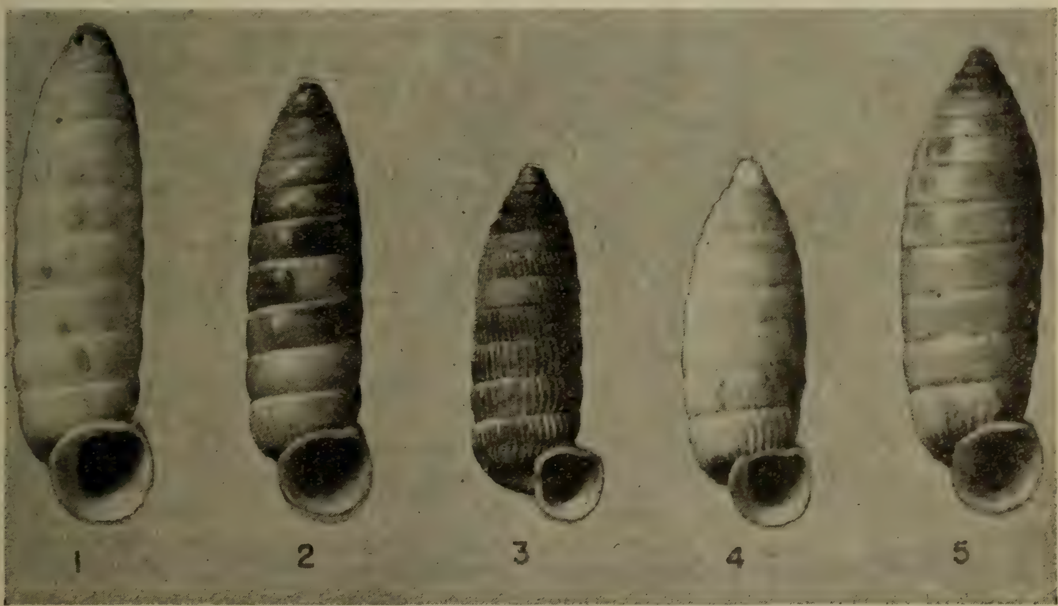


FIG. 1.—*Holospira teotitlana filia*. FIG. 2.—*Holospira t. teotitlana*. FIG. 3.—*Malinchea queretaroensis*. FIG. 4.—*Malinchea politecnicae*. FIG. 5.—*Malinchea arellanoi*. (All ×3½.)

specimens are entered as U.S.N.M. 431958; three are in Miss Bourgeois's collection.

Malinchea, new name

Tristemma Bartsch, Proc. U. S. Nat. Mus. 31: 133. 1906. (Not *Tristemma* Brandt, Prod. Anim. Mertens 1: 15. 1835.)

When I defined the genus *Tristemma* in 1906 I overlooked Brandt's previous use of this name. I am therefore rechristening the group as above.

Malinchea arellanoi, n. sp.
Fig. 5

Shell cylindroconic, bluish white, marked with a few feeble rust spots; interior of aperture and peristome white. The nucleus forms a slightly bulbous apex, which consists of 2.2 well-rounded, smooth turns. The early postnuclear whorls increase rapidly in size and are marked by well-developed, retractively slanting axial ribs, which are about half as wide as the spaces that separate them. These ribs vary somewhat in strength and spacing. On the succeeding whorls the axial ribs rapidly become diminished and completely disappear on the cylindric portion of the shell. On the last 1.5 turns, however, they recur and become very strong and almost vertical. The whorls on the cylindric portion are almost flattened and separated by a slightly impressed suture. Base moderately long, openly umbilicated, and marked by the axial riblets. Aperture obliquely broadly oval, slightly angulated at the posterior angle of the aperture. Peristome expanded and reflected, free at the parietal wall. The columella is rather broad and hollow, and in the penultimate whorl it bears a well-developed median lamellar fold. A broad, somewhat concave fold subtends from the parietal wall, while another a little less strong is present on the middle of the base. There is no indication of a fold or thread on the inside of the outer lip.

The type, U.S.N.M. 431959, was collected by Ing. A. R. V. Arellano and his students on a limestone hill 10 to 30 km north-northeast of Cadereyta, Querétaro, Mexico. It has 14.4 whorls and measures: Height, 18.3 mm; diameter, 7 mm.

U.S.N.M. 431960 contains seven topotypes from the same source; three more are in the collection of the Instituto Politécnico de México.

Malinchea politecnicae, n. sp.
Fig. 4

Shell rather small, cylindroconic, white with the peristome and the interior of the aperture yellowish white. The nucleus consists of about 2.2 whorls, which form a somewhat bulbous smooth apex. The early postnuclear whorls are marked by retractively curved, strong, axial ribs, which are separated by spaces a little wider than the ribs. The middle whorls are almost flattened and marked by strong incremental lines amounting almost to ribs, while the last two turns bear very strong, almost vertical, curved axial ribs, which are not quite so wide as the spaces that separate them. The suture is slightly impressed. The base of the last turn is narrowly openly umbilicated and marked by the continuation of the axial ribs. The aperture is irregularly ovate, angulated at the posterior angle. The peristome is expanded and reflected, free, and elevated at the parietal wall. The columella is rather broad and bears a strong median fold in the penultimate turn. Here also on the parietal wall is a moderately broad, concave lamella, while the basal wall in the same region bears a less elevated lamella. There is no sign of a lamella or thread on the inside of the outer lip.

This species comes from another limestone block 10 to 30 km north-northeast of Cadereyta, Querétaro, Mexico.

The type, U.S.N.M. 431961 has 12.2 whorls and measures: Height, 14.6 mm; diameter, 6 mm.

U.S.N.M. 431962 contains 12 topotypes and some fragments from the same locality. Five additional specimens are in the collection of the Instituto Politécnico.

This species resembles *Malinchea areallanoi* but can readily be distinguished from it by its smaller size and stronger axial sculpture.

Malinchea queretaroensis, n. sp.
Fig. 3

Shell small, cylindroconic, yellowish white, with the interior of the aperture and peristome pale yellowish white. The nucleus consists of 2.3 well-rounded, smooth turns which form a slightly bulbous apex. The early postnuclear whorls increase rapidly in size. These, as well as the rest of the whorls of the shell, are marked by strong, retractively slanting axial ribs,

which are almost sublamellose. The spaces separating these ribs vary from twice to three times the width of the ribs. Suture moderately constricted. Base of the last whorl short, rather widely openly umbilicated and marked by the continuation of the axial ribs. Aperture subquadrate. Peristome expanded and reflected; that of the parietal wall free. Columella rather broad. In the penultimate turns this bears a moderately strong fold, which is anterior to the middle. The parietal fold is very broad and lamellose and extends in its widest portion over more than half of the width of the whorls. The basal fold, on the other hand, is rather low when compared with the parietal fold. There is no indication of a fold or thread on the inside of the outer lip.

The type U.S.N.M. 431963, was collected by Ing. A. R. V. Arellano and his students on a limestone hill 10 to 30 km north-northeast of Cadereyta, Querétaro, Mexico. It has 13.5 whorls and measures: Height, 14.2 mm; diameter, 5.7 mm.

ICHTHYOLOGY.—*The discovery and redescription of the types of* Rivulus marmoratus *Poey, a cyprinodont fish from Cuba.*[1] LUIS RENÉ RIVAS, Museo de Historia Natural, Colegio de La Salle, Habana, Cuba. (Communicated by LEONARD P. SCHULTZ.)

While recently examining material of *Rivulus* in the United States National Museum, Dr. Leonard P. Schultz, curator of fishes, kindly called to my attention two specimens of Poey's, long ago labeled *Rivulus cylindraceus* Poey, and suggested that they were possibly a new species, since no fine-scaled *Rivulus* was recognized from Cuba by any current author. After careful examination of several facts and from circumstantial evidence, I am convinced that the two specimens are the types of *Rivulus marmoratus* Poey (1880: 248), and I submit the evidence below.

I wish to thank Dr. Schultz for calling these two specimens to my attention and am grateful for the opportunity to report on this Cuban fish, which has never been correctly diagnosed.

Rivulus cylindraceus Poey (1860: 308) was described first and is a coarse-scaled species that cannot be confused with the two fine-scaled specimens at hand. Furthermore, the types of *R. cylindraceus* are deposited in the Museum of Comparative Zoology; the holotype is a female bearing M.C.Z. No. 6423, a male paratype being in the same jar. There is another series of paratypes bearing M.C.Z. No. 6395 (see Luis Howell-Rivero, 1938: 176). I have examined these specimens and they agree with Poey's original description of *R. cylindraceus*. In addition, I have collected a fine series of topotypes that agree perfectly with Poey's description. Thus I have concluded that there can be no doubt cast on the current diagnosis of this species.

Poey's original description of *Rivulus marmoratus*, translated into English, reads as follows: "I have in my possession two specimens which I believe I have received from Dr. Rafael Arango; and they are from Cuba, if they do not exist in the United States of America, whence Professor Gill has sent me some species of *Cyprinodontes*. The ocular blotch indicates that they are males; they are 55 millimeters long.

"It differs from the preceding species [*Rivulus cylindraceus* Poey] in the more posteriorly inserted dorsal, because its distance to the caudal extremity equals that of said dorsal to the opercle, which is why the anal appears more advanced. The body is covered with dark and light blotches. A black blotch is noticed above the base of the pectoral fin.—No. 774."

This description by Poey fits exactly the two specimens under consideration, even in regard to the total length of about 55 mm. It is concluded that to have two of Poey's specimens of *Rivulus* 55 mm. in length in the same jar from Cuba is also additional evidence and especially significant. I believe, therefore that they are the two specimens described as *Rivulus marmoratus* Poey, and I recognize them as the types of that species.

[1] Received November 1, 1944.

Rivulus marmoratus, after examination of the pertinent literature, I conclude has been erroneously synonymized by most authors with *Rivulus cylindraceus* Poey (1860: 308), the only other Cuban representative of the genus, from which it differs widely. Jordan and Evermann (1896: 663) wrongly stated (footnote) that Poey was in error in indicating the existence of an ocellus above the pectoral origin. The ocellus, although somewhat faded after the long preservation, is present on both specimens, thus confirming Poey's description. Later, Myers (1927: 121) was in error in stating that Jordan and Evermann (l.c.) had mistaken the "anal" for the "dorsal" in Poey's original description of *Rivulus marmoratus*. A careful checking of Jordan and Evermann's account with Poey's description proves that these authors were correct in that respect.

The taxonomic status of this species and a redescription of the two types are given below.

Rivulus marmoratus Poey

Rivulus marmoratus Poey, 1880: 248 (original description; compared with *R. cylindraceus*).—Jordan, 1887: 564 (listed).—Garman, 1895: 134 (erroneously synonymized with *R. cylindraceus*).—Jordan and Evermann, 1896: 663 (description, after Poey),—Regan, 1912: 500 (erroneously synonymized with *R. cylindraceus*),—Myers, 1927: 121 (erroneously synonymized with *R. cylindraceus*),—Jordan, Evermann, and Clark, 1930: 179 (erroneously synonymized with *R. cylindraceus*).

I am designating as the lectotype U.S.N.M. 37429, a female 46.5 mm in standard length (56.5 mm total); the paratype, U.S.N.M. 123000, also a female, measures 45.5 mm in standard length (54.8 mm total).

Measurements are expressed in hundredths of the standard length. Throughout the description, the measurements and counts of the lectotype are given first, followed by those of the paratype in parentheses. For the methods followed in measuring and counting, see Rivas (1944: 41).

Greatest depth of body 19.8 (19.3); greatest width 18.3 (15.6); length of head 28.0 (27.3); greatest width 20.4 (19.1), greatest depth 14.2 (13.8); eye 6.7 (6.4); interorbital 12.7 (12.7); snout 8.2 (7.2); greatest width of mouth 11.2 (10.0); least depth of caudal peduncle 14.4 (13.8), length 21.5 (20.4); distance between anal origin and tip of mandible 61.7 (65.2).

Dorsal rays 8 (8); anal 10 (10); pectoral 13 (13); pelvic 6 (6); branched caudal 14 (14); origin of anal fin midway between caudal base and anterior margin of orbit in the lectotype; midway between caudal base and posterior margin of orbit in the paratype. Distance between dorsal and anal origins 21.1 (20.0); between dorsal origin and caudal base 26.9 (25.5); between anal origin and caudal base 36.8 (34.3); length of dorsal fin—19.6 (19.3); anal 24.1 (24.4); pectoral 24.1 (16.9); pelvic 6.9 (7.0); middle caudal rays 19.8 (18.9).

Scales in 48 (46) transverse rows and 14 (13) longitudinal rows; 18 (18) rows around caudal peduncle, and 15 (15) zigzag rows between pectoral bases; 35 (33) predorsal scales.

General coloration (in alcohol) reddish brown. A reddish-brown humeral spot (faded ocellus); both specimens have a dark spot (faded ocellus) on the upper part of the caudal base; there are faint traces of spotting on the dorsal, anal and caudal fins; pectoral and pelvic fins colorless; faint traces of spots all over the sides of the body.

This species differs from *R. cylindraceus* in the smaller scales (about 36 transverse rows in *cylindraceus*), smaller head, more advanced anal and other characters; the size seems to be larger. It resembles *R. hildebrandi* Myers (1927: 123) from Panama and *R. myersi* Hubbs (1936: 210) from Yucatán in having more than 42 transverse rows of scales. A direct comparison with these two species should be made.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1221st meeting

The 1221st meeting was held in the Cosmos Club Auditorium, Octobèr 23, 1943, President Seeger presiding.

Program: Robert Simha, Howard University: *Elasticity and flow in high polymers.*—The mechanical properties of high polymeric systems were considered in a state of equilibrium and in regard to rate phenomena such as creep, relaxation, volume-temperature, and volume pressure behavior. The characteristic differences between the molecular mechanism underlying elastic deformation in ordinary solids and in rubberlike polymers were discussed and conditions favorable for highly elastic response were pointed out. Creep was interpreted in terms of of a distribution of mechanical relaxation frequencies attributable roughly to three molecular mechanisms: the diffusion of chain segments in the field of stress, the change of shape of flexible chains under stress, and the relative displacement of the centers of gravity of the molecules which ultimately leads to flow. In a rubberlike system the relaxation spectrum is broad and the average time constant small. Oppression of "chain effects" by increased intensity of molecular interactions, excessive cross linking, or crystallization leads to a narrowing down of the spectrum and to an increase of the mean time parameter, as is characteristic for a plastic or fibrous material. The transition from ordinary to high elasticity upon increase in temperature was interpreted on the same basis as the transition points observed by means of thermal expansion and specific heat data and those to be expected in the volume-pressure curves. Finally the importance of mechanical absorption and dispersion measurements below and above the transition temperature was pointed out. (Author's abstract.)

1222d meeting

The 1222d meeting was held in the Cosmos Club Auditorium, November 6, 1943, President Seeger presiding.

Program: R. Weller, Naval Ordnance Laboratory: *Photoelasticity.* (Abstract not received.)

1223d meeting

The 1223d meeting was held in the Cosmos Club Auditorium, November 20, 1943, President Seeger presiding.

Program: L. B. Tuckerman, National Bureau of Standards: *Mathematics as she are taught: Fit the Second.—Part I:* Teachers of college physics have long recognized that if they are to inculcate correct ideas they must spend a large part of their time in eradicating many misconceptions about mathematics, physics, and science in general, which are firmly entrenched in their students' minds. In recent numbers of the American Journal of Physics[1] there are listed 158 current misconceptions. In discussing this problem Prof. Henry A. Perkins[2] says: "They originate in outworn notions whose vitality is perennial, in lack of clarity or in positive misstatements in text books and in previous faulty instruction."

A fruitful source of such faulty instruction was recently brought to my attention by a very favorable review of *A Source book of mathematical applications*, 17th Yearbook of the National Council of Teachers of Mathematics,

[1] Vol. 11: 101–102, 110–111, 164–165, 227–228. 1943.

[2] *L.c.*, p. 101.

published by the Bureau of Publications, Teachers College, Columbia University, New York, 1943, and planned as a "reference book for the teachers of the mathematics usually offered in grades seven through twelve."

It seems incredible, but it is unfortunately true, that in this book there is crowded more misinformation than I have ever seen within the covers of a single book issued by a supposedly reliable organization. It abounds in grossly careless proofreading, in careless checking of references, in confusion of units such as "knots per hour," "force" for energy, "watts consumed . . . in one hour," in careless statements and even in sheer asininities—boners which deserve to be immortalized in a book devoted to boners. Numerous quotations from the book were given as illustrations of these statements. Students have enough difficulty with mathematics as it is ordinarily given in schools without being further confused by the absurdities printed in this book.

Part II: Recently there appeared in my mail a flamboyant advertisement of the "National Educational *Alliance*" announcing a "vital new 180-day Emergency Short" . . . "*N.E.A.* Course in PRACTICAL MATHEMATICS" containing amongst a plethora of other eulogistic statements the following:

5. . . . No previous Mathematics Knowledge Needed . . . .

6. . . . ANY AVERAGE PERSON can readily acquire . . . .

Not in 4 Years, but Only 6 Months—a Practical Working Knowledge of ALL 14 Branches of Mathematics—Arithmetic, Algebra, Geometry, Trigonometry, Calculus, etc., and their Practical Applications to Machine Shop, Engineering, Chemistry, Electricity, Navigation, Aviation, Gunnery, Business, etc.

Many similar advertisements come in my mail. I usually glance at them and drop them in the waste basket, though I have called some of them to the attention of the Post Office and some to the Federal Trade Commission only to learn that they were so carefully worded that, although they were false and even fraudulent in their implications, under our present laws no action could lie against the advertisers.

This advertisement, however, I did not drop in the waste basket. My eye was caught by the words: "*No Single Faculty Ever Could Proclaim such a Distinguished Group of Mathematicians.*" In the list of names following were two members of the National Academy of Sciences and nine other professors of mathematics in some of our largest universities and technical schools.

What sort of mathematics teaching can we expect when the names of such distinguished mathematicians appear as sponsors on such an advertisement? (*Author's abstract.*)

An informal communication on the measurement of temperature in moving aircraft was presented by Mr. BROMBACHER.

1224TH MEETING

The 1224th meeting, constituting the 74th annual meeting, was held in the Cosmos Club Auditorium, Saturday, December 4, 1943, President SEEGER presiding.

The Treasurer reported that the income from dues and from interest on investments was \$1,196.99 and that the expenditures, other than investments, were \$1,138.74, leaving a net surplus of \$58.25 on ordinary expenses. The ordinary expenditures were at the rate of \$3.55 per member. The Treasurer reported the sale of a \$1,000 Bond of Fort Dodge, Des Moines & Southern Railway for \$269.25.

The Secretaries' joint report showed an active membership as of December 1, 1943, of 321, of whom the following were new members: ARTHUR D. BERNSTEIN, RALPH MOORE BERRY, RICHARD S. BURINGTON, HOWARD F. CARL, DONALD H. JACOBS, PAUL J. KOPP, WALTER H. MACWILLIAMS, JR., ALBERT MAY, LAWSON M. MCKENZIE, ROBERT G. NUGENT, WILLIAM R. OSGOOD, ELIZABETH RONA, ANATOL J. SHNEIDER, SIDNEY T. SMITH, F. LEO TALBOTT, and HAROLD O. WYCKOFF. They reported the following deaths: ALAN S. HAWKESWORTH, JAMES E. IVES, G. W. LITTLEHALES, CHARLES F. MARVIN, and NATHAN S. OSBORNE.

Following the report of the Committee on Elections, the following officers were declared elected for the year 1944: President, H. F. STIMSON; Vice-Presidents, CLEMENT L. GARNER and GEORGE R. WAIT; Corresponding Secretary, WALTER RAMBERG; Treasurer, FRANCIS E. JOHNSTON; Members-at-Large of the General Committee, FRANK C. KRACEK and ALBERT K. LUDY.

Program: S. CHANDRASEKHAR, Yerkes Observatory: *Galactic evidences for the time scale of the universe.*—Galactic star clusters like the Pleiades and the statistics of double stars pro-

vide two independent sources of information for drawing inferences concerning the time scale of the universe.

Considering first star clusters, we can readily show that they are continually being impoverished by the gradual escape of stars. An estimate of this escape of stars will therefore provide a means for determining the average life of a star cluster. And it is found that the mean life of a cluster like the Pleiades is about 3×10^9 years.

With respect to binary stars, it is clear that as a consequence of the tidal effects of the neighboring stars, double stars should gradually tend to be disrupted. An estimate of this gradual dissolution of binary stars shows that binaries with separations between 1,000 and 10,000 astronomical units will be disrupted in times ranging from 7×10^{10} to 2×10^9 years. However, the number of known binaries in the range specified is far too large to be compatible with a time scale long compared to 3×10^9 years.

Thus both the star clusters and the binaries agree in indicating a time scale of 3×10^9 years. (*Author's abstract.*)

1225TH MEETING

The 1225th meeting was held in the Cosmos Club Auditorium, December 18, 1943, President STIMSON presiding.

Program: ATHERTON H. MEARS, Weather Bureau: *Electrical instruments for meteorological measurements.* (Abstract not received.)

An informal communication on paper folding, with a demonstration of the construction of the regular octahedron, was presented by Mr. GOLDBERG.

1226TH MEETING

The 1226th meeting was held in the Cosmos Club Auditorium, January 15, 1944, President STIMSON presiding.

The Retiring President, R. J. SEEGER, gave an address entitled *On understanding electric breakdown in solids.* It will be published in this JOURNAL.

1227TH MEETING

The 1227th meeting was held in the Cosmos Club Auditorium, January 29, 1944, President STIMSON presiding.

Program: E. H. KENNARD, Cornell University, and DAVID TAYLOR, Model Basin: *Why be scientific.*—A striking feature of the natural sciences, in contrast to the continual fluctuation of opinion in certain other fields, is the steady growth of a large body of well-established facts and laws. This feature is to be ascribed in part to the employment of a characteristic method. Neither the use of experiment, however, nor of measurements, nor of mathematics, nor of theories is essential; for, in spite of their enormous value, each of these procedures is absent in much scientific work. The basic unifying principle in all sciences appears to be the search, by any means available, for objective knowledge, that is, for conclusions acceptable to all honest and sane men who will take the trouble to inform themselves.

Two subsidiary universal procedures are the adequate definition of terms and a principle of restraint; problems that cannot as yet be attacked receive little emphasis or discussion.

Extension of the scientific method to other fields is going forward. The ultimate basis of values, however, lies in the realm of feeling and so is not a question of truth. Furthermore, scientists should be distinguished from practitioners, who are compelled to do something about practical problems even in the absence of relevant scientific knowledge. (*Author's abstract.*)

An informal communication on a curious and interesting little point in the theory of electric circuits was presented by Mr. OSGOOD.

1228TH MEETING

The 1228th meeting was held in the Cosmos Club Auditorium, February 12, 1944, President STIMSON presiding.

Program: RICHARD S. BURINGTON, Case School of Applied Science: *Invariance in science.*—This lecture was concerned with applications of the theory of invariance as it permeates various old and modern physical theories.

As an introduction, an elementary but brief survey of various types of geometries (translational, rotational, affine, projective), their groups of fundamental invariants, was given. Many illustrations from various fields of physics were included, both classical and modern.

Brief reference was made to the fundamental items of invariant theory in general, with mention of the case when the underlying transfor-

mations do not necessarily form a group. A short summary was given of the role of invariants in certain mathematical fields that appear in physics; in particular, brief mention was made of differential invariants, the existence of fundamental systems of invariants, the invariant characterization of boundary value problems and their relation to characteristic values and quadratic forms and their principal invariants.

The meaning and significance of invariants both in mathematics and in physical situations were stressed and carefully illustrated. In particular, to indicate the nature and role of invariants in a physical field, considerable use was made of the set of energy quadratic forms commonly considered in linear dynamics and electrical circuit theory, together with its principal invariants, under a group of *m*-affine transformations.

Specific mention was made of the trend of the concept of invariance in Newton's theory of the universe, Maxwell's theory of electrodynamics, and Einstein's special theory of relativity.

A short résumé of the part played by invariance in various other parts of physics, engineering, economics, and the medical and social sciences was included.

Some indication of the trend that theories of invariance may take in the future was discussed in a broad way. (*Author's abstract.*)

An informal communication on the origin of the Japanese Nation was presented by Mr. SHNEIDEROV.

1229TH MEETING

The 1229th meeting was held in the Cosmos Club Auditorium, February 26, 1944, President STIMSON presiding.

Program: RICHARD C. DARNELL, Office of the Chief of Ordnance, War Department: *The problem of antiaircraft fire control.*—Antiaircraft fire-control systems vary in complexity from the simplest for .50-caliber machine guns, the more elaborate for intermediate caliber weapons (37 and 40 mm material), to the most complex and precise for the major caliber guns, which comprise the 3 inch, 90 mm, 105 mm, and larger cannon.

A major caliber system will include sound locators or other devices for early warning and location of hostile aircraft, and searchlights for their illumination at night. These are placed some distance in advance of the gun battery. The present angular position in azimuth and elevation is determined by optical tracking of the target by the Director. A $13\frac{1}{2}$-foot base optical height finder is used to measure either the slant range or height of the target. From these data the target's future position, after the interval required for the travel of the projectile, is calculated and corrections then applied for horizontal and vertical parallactic displacement of the guns, gravity drop, wind, drift, air density, and muzzle velocity. This solution is transmitted by a self-synchronous data transmission system to the guns, which are automatically oriented in aximuth and elevation by an electronic-hydraulic remote control device in accordance with the data received. A fuse setter cuts the mechanical timer fuse on the projectile so as to cause it to explode at the expiration of the computed time of flight. (*Author's abstract.*)

1230TH MEETING

The 1230th meeting was held in the Cosmos Club Auditorium, March 11, 1944, President STIMSON presiding.

Program: IRVEN TRAVIS, Bureau of Ordnance, Navy Department: *Differential analyzers.* (Abstract not received.) In the discussion Mr. SHNEIDEROV called attention to the existence of a paper, *A mechanical integrator for the solution of ordinary differential equations,* referring to an instrument designed by A. J. Zavrotzky, available at the Smithsonian Institution.

The Secretary read a letter from MARY G. WORTHLEY, of Western High School, on the the paper *Mathematics as she are taught, fit the second* presented by Mr. TUCKERMAN on November 20, 1943. It was discussed by Mr. TUCKERMAN.

1231ST MEETING

The 1231st meeting was held in the Cosmos Club Auditorium, March 25, 1944, President STIMSON presiding.

Program: HERBERT G. DORSEY, U. S. Coast and Geodetic Survey: *Radio applied to ocean current observations.*—This instrument, developed by Lt. Comdr. E. B. ROBERTS, of the Coast and Geodetic Survey, consists of a radio transmitter in a floating buoy anchored at the place where observations are desired actuated

by a meter suspended beneath. Vertical vanes on the meter cause it to face the current and an impeller rotates as a function of the current flow. A magnetic drive in the impeller communicates motion to the interior without friction. An alnico compass is pivoted over a horizontal gear, rotating at $\frac{1}{3}$ the speed of the impeller. The horizontal gear carries a planetary rotating at 3/2 the speed of the horizontal. Contacts are arranged to close an electrical circuit on each revolution of the horizontal about the vertical axis of the compass and every other revolution of the planetary. A pair of wires passing through stuffing boxes in the meter and buoy operate a relay to send a radio dash from the battery operated crystal controlled radio transmitter. These dashes are received at a central station, preferably on a surveying ship and actuate a tape chronograph. Dashes by pairs give the velocity of the water and the third dash, by its spacing between the others, gives the direction. Observations are made at several locations by tuning the receiver to different buoys using different radio frequencies. (*Author's abstract.*)

An informal communication on a misconception concerning crystallization in metals, and its appearance in the literature was presented by Mr. Tuckerman.

An informal communication on the differentiation of empirical functions was presented by Mr. Blake.

1232d meeting

The 1232d meeting was held in the Cosmos Club Auditorium, April 8, 1944, Vice-President Wait presiding.

Program: George F. A. Stutz, New Jersey Zinc Co. (of Pennsylvania): *Luminescent pigments* (illustrated).—Luminescent materials are described as capable of absorbing invisible ultraviolet light and re-emitting visible light. They are divided into two classes: fluorescent materials glow only while the activating light shines on them; phosphorescent materials continue to glow after the activating light is extinguished. Fluorescent materials include a wide variety of organic dyes, dye intermediates, metallo-organic compounds, and zinc and cadmium sulphides. Phosphorescent materials include zinc sulphide, zinc and cadmium sulphide, calcium sulphide, and strontium sulphide. Activation of these materials is accomplished by a variety of sources of ultraviolet light, including daylight.

Fluorescent materials are used in plastics, wool, silk, cotton or paper, lacquers, printing inks, and powders. Phosphorescent materials are somewhat more limited in application because of coarse particle size. They may be fabricated in plastics, paints, and vitreous enamels. The phosphorescent materials are useful only where their low brightness is adequate. In general, this requires complete or nearly complete darkness and dark-adaptation of the observer.

Radioactive materials are a third type of luminescent materials, the activation in this case being furnished by an admixed radium compound. Such materials require no activation by external light sources.

The application of luminescent materials in the present war effort has resulted in a number of newly developed pigments and in a greater variety of practical applications. A demonstration of prewar applications, wartime applications, and possibly postwar applications is given. (*Author's abstract.*)

1233d meeting

The 1233d meeting was held in the Cosmos Club Auditorium, April 22, 1944, President Stimson presiding.

Program: John G. Kirkwood, Cornell University: *The structure of liquids.*—The structure of liquids on the molecular scale has been investigated on the experimental side by the X-ray scattering technique and on the theoretical side by the methods of statistical mechanics. Although liquids lack the long-range order characteristic of crystal lattices, they are found to possess residual local order maintained by each molecule in its immediate environment. Local order in liquids is characterized by the radial distribution function, which specifies the average local molecular density in the vicinity of any given molecule. The radial distribution function is characterized by a series of rapidly damped maxima and minima corresponding to a blurred crystalline arrangement of neighbors merging into randomness at distances of several molecular diameters.

The X-ray scattering technique for the investigation of liquid structure was originated by Zerniekie and Prins and by Debye and Mencke. By means of a Fourier integral inver-

sion the radial distribution function may be calculated from the intensity of scattered X-rays measured as a function of scattering angle. The method has been employed to investigate the structure of many liquids and gases.

The methods of statistical mechanics have been used to determine the relationship between the radial distribution function of a liquid and the intermolecular forces acting between its molecules. In this manner it has been possible to make a theoretical analysis of liquid structure and to establish its connection with thermodynamic and other bulk properties of a liquid. (*Author's abstract.*)

An informal communication on focal plane properties of a telescope was presented by Mr. Archie Mahan.

1234th meeting

The 1234th meeting was held in the Auditorium of the U. S. National Museum, April 29, 1944, President Stimson presiding.

The thirteenth Joseph Henry lecture, entitled *Faster than sound*, was delivered by Theodore von Karman, of the California Institute of Technology. It will be published in this Journal.

1235th meeting

The 1235th meeting was held in the Cosmos Club Auditorium May 20, 1944, President Stimson presiding. *Program:* Dean B. Cowie, Department of Terrestrial Magnetism, Carnegie Institution of Washington: *The 60-inch cyclotron at the Department of Terrestrial Magnetism.*—The operation of a large cyclotron is dependent upon a large number of electrical and mechanical components functioning in unison. This paper outlined the theory of operation of the instrument and indicated the large number of safety factors included in its construction to assure continuous reliable operation.

The principles of artificial radioactivity were briefly discussed to indicate ultimate use of the products of the cyclotron in medicine, physics, and industry. Perhaps the most important use could be ascribed to the "tracer technique of radioactivity" where the various radioactive isotopes are used to follow chemical and biological processes heretofore impossible by other means.

Some discussion was made concerning the protection of personnel both from the large amounts of radiation produced by the cyclotron and from the electrical hazards associated in its operation. A specially designed building housing the instrument incorporates many automatic safety measures eliminating many sources of danger. (*Author's abstract.*)

Mr. Tuckerman presented an informal communication on lack of rigor in textbooks of calculus.

Archie Blake, *Recording Secretary*

CHEMICAL SOCIETY

564th Meeting

The 564th meeting was held at George Washington University on October 12, 1944. At the conclusion of a general meeting the following divisional meetings were held:

Biochemistry, Hugh J. Creech, *presiding*

Some properties of cystine oxidase. J. P. Greenstein (National Cancer Institute).

The determination of tryptophane in proteins and foods. (a) *A rapid colorimetric method for the determination of tryptophane.* M. J. Horne and D. B. Jones (Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture). (b) *Two microbiological methods for the determination of 1-tryptophane.* G. G. Wooley and W. H. Sebrell (National Institute of Health).

Organic Chemistry, L. W. Butz, *presiding*

The phosphorylation of 4,4′-diaminodiphenylsulfone and conversion of the products into amidophosphoric acid derivatives. Ernest L. Jackson (National Institute of Health).

A study of the direction of enolization of 3-nitro-4′-methoxydibenzoylmethane. R. Percy Barnes and Jonathan L. Snead (Howard University).

The cyclopentenolone components of pyrethrins. F. B. LaForge and W. F. Barthel (Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture).

Physical Chemistry, M. H. Van Horn, *presiding*

The use of the mass spectrograph in studies of hydrocarbon mixtures. A. Keith Brewer (National Bureau of Standards).

The mechanism of certain organic reactions in non-aqueous solvents. A. L. Sklar and John Duffie (Catholic University of America).

The determination and elimination of liquid junction potentials. GEORGE F. MANOV, N. J. DA LOLLIS, and S. F. ACREE (National Bureau of Standards).

Inorganic and Analytical Chemistry,
R. E. STEVENS, *presiding*

New developments in the use of sealed tubes in chemical analysis. C. L. GORDON, W. G. SCHLECHT and EDWARD WICHERS (National Bureau of Standards and U. S. Geological Survey).

Internal structure and decomposition of crystalline materials. W. G. SCHLECHT and K. J. MURATA (U. S. Geological Survey).

Spectrographic sensitivity of elements in silicate materials. K. J. MURATA (U. S. Geological Survey).

Analytical patterns in inorganic analysis: Applications to mineralogy, metallurgy, and histology. HERMAN YAGODA (National Institute of Health).

565TH MEETING

The 565th Meeting was held at the Cosmos Club on November 9, 1944. Dr. KENNETH C. D. HICKMAN, Distillation Products, Inc., spoke on *An in vitro chemistry of nutrition (with special reference to vitamins A and E).* The election of officers for 1945 was held with the following results: President, H. S. ISBELL; Secretary, L. A. SHINN; Treasurer, J. J. FAHEY, Councilors, N. BEKKEDAHL, N. L. DRAKE, W. L. HALL, H. L. HALLER, W. J. HAMER, F. C. KRACEK, B. H. NICOLET, N. K. RICHTMYER, J. H. ROE, E. R. SMITH, B. D. VAN EVERA, J. K. WOLFE; Managers, R. GILCHRIST, A. T. MCPHERSON, W. I. PATTERSON, J. L. SVIRBELY, W. W. WALTON, C. E. WHITE.

566TH MEETING

The 566th meeting was held at the Cosmos Club on December 14, 1944. Dr. NORMAN BEKKEDAHL, of the National Bureau of Standards spoke, on *Rubber research in tropical Brazil.*

LEO A. SHINN, *Acting Secretary*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting held January 16, 1945, elected the following officers: President, T. DALE STEWART; Vice-President, REGINA FLANNERY; Secretary, WILLIAM N. FENTON; Treasurer, WALDO R. WEDEL; Members of the Board of Managers, W. M. COBB, WM. H. GILBERT, ALFRED MÉTRAUX, MAURICE A. MOOK, and JULIAN H. STEWARD.

A report of the membership and activities of the Society since the last annual meeting follows:

Life members, 1; active members, 63; Associate members, 24; total, 88. This represents an increase of 21 over last year.

The members elected during the year were: Dr. JOHN M. ARMSTRONG, Rev. HUGH BIHLER, S.J., HUNTINGTON CAIRNS, JOSEPH BLAKE EGGEN, WILLIAM LEO HANSBERRY, Mrs. ANNE FROMME HERTFORD, Dr. FREDERICK S. HULSE, Dr. EDWIN M. LOEB, ERNEST MAES, Dr. PEVERIL MEIGS, JOHN A. POPE, Sister LUCIA VAN DER EERDEN, Dr. A. J. WARING, JR., active members; Mrs. SUSAN W. ARMSTRONG, Miss ELIZABETH BACON, Lt. FREDERICA DE LAGUNA, U.S.N.R., GORDON W. HEWES, Lt. W. W. HOWELLS, U.S.N.R., Lt. Comdr. A. H. LEIGHTON, U.S.N.R., Dr. DOROTHEA C. LEIGHTON, Dr. MARGARET MEAD, Dr. J. S. SLOTKIN, Dr. LAURA THOMPSON, Dr. GEORGE L. TRAGER, Capt. WILLIAM L. VAN NESS, associate members.

One member, Dr. WILLIAM H. SPINKS, active member since 1942, was lost through death. The Society voted to record its deep sense of loss at the death of this member and to extend its sincere sympathy to his wife.

The report of the Treasurer follows:

Funds invested in Perpetual Building Association (with interest to July 1, 1944)	$1,789.35
21 shares Washington Sanitary Improvement Co. (par value $10 per share)	210.00
2 shares Washington Sanitary Housing Co. (par value $100 per share)	200.00
U.S. Savings Bond, Series G	500.00
Cash in bank	257.39
	$2,956.74

Bills outstanding:	
To American Anthropological Association (subscriptions to American Anthropologist for 4 members at $5 each)	20.00
To Ricker Printing Co.	21.48
	$2,915.26
Total as of January 17, 1944	2,959.04
Decrease	$ 43.78

The Society acted as host to the Society for American Archaeology on the occasion of its annual meeting on May 13, 1944, at the Cosmos Club.

All regular meetings were held at the U. S. National Museum. The May meeting was the occasion of a dinner in honor of Dr. ETHEL JOHN LINDGREN at the National Zoological Park restaurant. Continuing a practice adopted in 1942 of keeping the mailing list current with the roster of anthropologists in Washington, the Secretary has sent out an average of 180 notices for regular meetings. The Washington Urban League members were invited to the November meeting; the social scientists in the Department of Agriculture were invited to the January meeting; 600 invitations went out for Mrs. Roosevelt's lecture, including the membership of the Washington Academy of Sciences.

The Society has continued to enjoy the presence in the Capital of a large number of anthropologists. Some of them have joined our ranks and others have delivered papers. The programs of meetings during the first months of the year continued under the direction of a committee headed by the Secretary. This group, having served two years, requested that a new committee be appointed. The President appointed Dr. JULIAN H. STEWARD chairman and asked Dr. GORDON R. WILLEY and Dr. W. R. WEDEL to serve with him. Turning from the anthropology of war areas, with occasional discussions of theoretical anthropology, the new committee initiated a series of symposia: first, on New World Prehistory, followed by a series of Discussions of Anthropology and Contemporary Problems.

Titles of papers presented before the regular meetings of the Society were as follows:

January 18, 1944, 717th meeting, Dr. GORDON T. BOWLES, *Probable developments in the field of comparative racial anatomy.*

February 15, 1944, 718th meeting, ELEANOR R. ROOSEVELT, *Civilization in the South Pacific.*

March 21, 1944, 719th meeting, RUTH EVANS PARDEE, *Some aspects of Minankábau society.*

April 18, 1944, 720th meeting, Dr. HOMER G. BARNETT, *Emotional factors in cultural change.*

May 31, 1944, 721st meeting, Dr. ETHEL JOHN LINDGREN, *Some current trends in British anthropology.*

October 17, 1944, 722d meeting, Dr. GORDON R. WILLEY, Dr. FRANK H. H. ROBERTS, JR., and Dr. WALDO R. WEDEL, symposium on *Dating in New World Prehistory.*

November 21, 1944, 723d meeting, Discussions of Anthropology and Contemporary Problems—I, Dr. RAYMOND KENNEDY, *Anthropology and Colonial administration.*

December 19, 1944, 724th meeting, Discussions of Anthropology and Contemporary Problems—II, Symposium on *Race contacts and race conflicts;* Dr. MORRIS E. OPLER, *American White-Oriental relations;* Dr. ARTHUR RAPER, *American White-Negro relations;* and Dr. ALFRED MÉTRAUX, *Race relations in Latin America.*

WILLIAM N. FENTON, *Secretary*

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This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued monthly, on the fifteenth of each month. Volumes correspond to calendar years.

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JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

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ETHNOLOGY.—*The Sinhalese caste system of central and southern Ceylon.*
WILLIAM H. GILBERT, JR., Library of Congress. (Communicated by W. N. FENTON.)

(*Continued from page 87.*)

OUTCASTES

The *Rodiyas*, or Outcastes, had the following names, according to Upham (vol. 3, p. 351): *Rogadikayo*, i.e., incurably sick men because they were originally lepers; *Adarmishtayo*, i.e., unrighteous men because they were addicted to bestiality; and *Wasalo*, or *Wasalayo*, i.e., subject to all because they were below all other castes in status. The term *Rodia* is stated to be a corruption of *Rogadikayo*. They were also called *Antere Jaty*. The euphemistic terms employed for *Rodia* were *Hulawaliya* (title of a headman of this caste) and *Madukaraya*, or rope man because they made ropes. (Valentyn, *in* Philalethes, p. 351.)

The *Rodiyas* have engaged the attention of writers on Ceylon out of all proportion to their numbers and comparative importance. They were always a small group and found in but few areas. Their primary duty in the Kandian Kingdom was to supply prepared leather for drums and ropes of hide, halters, thongs, and cords for cattle, as well as to bury carcasses of dead animals found on the estate to which they belonged. (A. A. Perera, p. 337; Knox, *in* Philalethes, pp. 139–142; Parker, 1917, pp. 29–30.) They were occasionally called *Gasmundo* as a euphemism based on the fact that they used a rope by this name for catching and fastening elephants to trees. They were of a wandering, gypsylike character and given to begging, but they are not to be confused with the true gypsies in Ceylon, the *Ahligunthikayo*. The *Rodiyas* were not exempted from taxation, and their services to the king were supplied supposedly because of the land allotted for their village or camp sites and the alms they were given. (Pridham, vol. 1, pp. 241–243. For the true Ceylon gypsies see Spittel, pp. 229–244, and Bell, pp. 108–114.)

Only the village charcoal burner or the King's gaoler communicated with *Rodias* and then generally at a distance. *Rodiya* dwellings were the merest sheds open completely on one side. Their hamlets, or *cupayas*, were miserable collections of these hovels temporarily erected until the band moved on elsewhere. In carrying a *pingo* load they were required to load it at one end only. If a *Rodia* met a *Goigama* he was required to salute with uplifted hands and move out of the way or, if the way was too narrow, to retreat to a distance until the higher caste man passed by. *Rodias* were barred from temples and were in general absolutely untouchable. They were not allowed the use of white linen and were required to tie the hair in a knot on the top of the head. (Pridham, vol. 1, pp. 241–243. Tennent, vol. 2, pp. 187–191, compares the *Rodias* with the Cagots of the French Pyrenees, the latter group being also of reputed leper origin and engaged in occupations similar to the *Rodias* with corresponding outcaste position.)

Rodia women were often given the euphemistic designation of *Nettukkaraya*, or dancers, and were skilled in that art and in fortune-telling. They were prohibited from wearing clothing above the waist but were attractive and often found favor in the eyes of men of the higher castes. It has been asserted that not only the women but also the

men were in general robust and physically well developed. (Davy, pp. 129–131, See list of illustrations of castes in Appendix V herein.)

Traditionally the *Rodiyas* were degraded by a king because they ate human flesh and beef. They were not reputed to be trustworthy and much of the thefts or other damage to property was attributed to them. When displeased with the alms given it was claimed that they were especially prone to vandalism. The census of 1901 gave their number as 1,464, of 1911 as 1,573, and of 1921 as 1,619.

The patron goddess of *Rodiyas* was Navaratna Valli, who was born from the Telembu Tree (A. A. Perera, 1917, p. 19).

PALANQUIN-BEARERS

The Palanquin-bearers were called by the following terms, according to Upham (vol. 3, p. 349): *Baddo*, or *Paddo*, a derivative of *Padiwo* and meaning rice-makers; *Batgammu*, *Batgamayo*, or *Batgama Etto*, i.e., rice-village, people because they cultivated the rice in villages for the Kandian king.

The Palanquin-bearers lived in *Batgama* villages. According to Davy the *Paduwo*, or Palanquin-bearers, were divided into three sections: (1) the *Paduwo* proper, who were fairly numerous and paid a pecuniary tax, built walls for houses, thatched roofs, carried loads, fetched wood and ornaments for archways, and carried objects in processions; (2) the *Yamanoo*, or ironworkers, who smelted iron for the Kandian king; and (3) the *Gahalagambadayo*, or *Gahalayo* a very degraded section who were not allowed to eat or intermarry with the other divisions and who served as executioners, street sweepers, and removers of carcasses. Of the latter group one subsection ate beef and were held to be lower than the rest. The washermen for *Gahalayo* were called *Hinawo*. (Davy, pp. 127–128; Pridham, vol. 1, p. 240.)

In general the Palanquin-bearers were a lowly caste. They were not permitted to wear a cloth that reached below the knees, and the women were not allowed to wear one over their shoulders or to conceal the upper parts of their bodies. When carrying palanquins the *Paduwo* were allowed to carry only males, the Jaggery-makers (*Wahumpura*) carrying the palanquins of females. (Pridham, vol. 1, p. 240.) According to one account the *Paduwo* could carry only the hinder part of the palanquin of a *dissawa*, or high official. They served also as watchmen and performed a variety of menial duties.

Although some *Paduwo* paid a poll tax and served as *lascoreens* (soldiers), they were not allowed to acquire any permanent rights in land and were always at the disposal of the king (*ibid.*). According to Arthur Perera (1903, p. 337) the Paduwo tenants were required to furnish onions and garlic (*lunubadda* duties).

Upham (vol. 3, p. 348) gives the following synonyms for the *Gahalayo*, or Scavengers: *Pookoosayo*, i.e., removers of city dirt; *Pupphachaddakayo*, i.e., casters away of flowers because they removed the faded flowers from temples; *Kasalayo*, or throwers away of dirt; and *Gahalagambadayoo*, i.e., elephant or other carcass removers. They inhabited the *Gahala-gama* villages (Pridham, vol. 2, p. 491). The census of 1891 listed 99 Sinhalese scavengers and that of 1901 some 120.

The position of the *Paduwo* in relation to ironworking is not clear. According to A. A. Perera (1903, p. 337) the *Paduwo* tenants brought charcoal for the smith and worked at the bellows as *yamanu*. Pridham (vol. 1, p. 240) says that the *Yamanoo* were iron-smelting *Paduwo* and were required to furnish the king's store and the district headman with a certain quantity of iron for their land tenures. This does not clarify their exact relation to the ironworking smiths.

The term *Duraya* appears to have been employed in recent years for the laboring castes that performed Palanquin-bearing duties. Perera lists five classes of Durayas: (1) *Kande duraya*, or molasses-makers (*Wahumpura*); (2) *Batgam duraya*, or palanquin-bearers; (3) *hunu duraya*, or lime-burners; (4) *Valli duraya*, or cloth-weavers; and (5) *panna duraya*, or bringers of fodder for elephants and cattle. (A. A. Perera, 1917, App. p. xxiv, *Yamanna*.)

The *Duraya* caste were required to provide the manorial lord with uncooked provisions, such as vegetables and raw rice, as part of their services (*ibid.*). Parker (1917, p. 29) asserts that *Duraya* women could not wear above the waist more than a strip of calico about a hand's breadth across the breasts and that later a colored handkerchief took the place of this article.

Pridham (vol. 2, p. 491) tells us that *Paduwo* were numerous in the Moderagam Valley of Northern Province, where they drew sound from earthen pots with the breath and kept admirable time in the dance.

POTTERS

The terms for Potters, according to Upham (vol. 3, p. 345), were: *Cumbakarayo* and *Culawlayo* after Coombeya and Culala, eponymous ancestors who were the reputed first Potters; *Pandittayo,* or wise men, because they made their wares according to their own fancy without any previous pattern; *Bada Sellaya,* i.e., possessors of near halls because they burned their wares in halls or places close to their dwellings; and *Cumballu,* another name derived from Cumbakarayo. According to another version (Denham, p. 189) the name *Pandittayo* derives from the name for scholars because a tradition tells of a scholar who once disguised himself as a potter in order to escape a king's wrath. Other terms in common use were *Baddaballaya, Badahela, Cubello,* and *Kumballa.*

The Potters were fairly numerous and paid a small tax in money for their lands in addition to furnishing the kitchens of the king and nobles with earthenware. Because all earthenware vessels used at a feast were destroyed immediately thereafter through fear of pollution or disgrace by lower caste contamination, the demand for new pottery was fairly high. Thus the fear of caste contamination or disgrace aided the Potter's trade. (Pridham, vol. 1, p. 238.)

In addition to pottery this caste also made tiles and helped repair roofs of this material, made bricks for walls, and manufactured clay lamps and other pottery objects for temples and for festivals or rites. Some Potters were attached to temple properties and were required to service these institutions. Potters had *Dureas* or overseers and were required to pay a poll tax or deccum. Coomaraswamy, pp. 25, 218 ff., gives examples of Potters' work songs. Potters did not have the privilege of wearing white linen, nor could they wear any doublets or any cloth much below the knees. They might not sit on stools, and *Goigama* would only give them drink by pouring the water. (A. A. Perera, 1917, App. p. ii, *Badahela-Panguwa;* Valentyn, in Philalethes, p. 327 ff.)

The flag of the Potters bore a wheel as the symbol of the caste (E. W. Perera, p. 5). According to Parker (1917, p. 28) some of the Potters undertook service as priests for the ceremonies of propitiating planets or other evil bodies and served as astrologers. The census lists 5,255 Sinhalese potters in 1881, 11,248 in 1891, and 9,678 in 1901.

SLAVES AND MINOR CASTES

Slaves were in general deemed to belong to the *Wallu,* one of the low castes, but these again were subdivided into at least three groups, namely, *Covias, Nalluas,* and *Pallas.* The *Covias* were domestic servants. (Pridham, vol. 1, p. 241.)

In the management of slaves the restrictions of caste could not be neglected by the owners, and no one might hold as a slave a member of a caste higher than his own. (Coomaraswamy, p. 22.)

The origin of the slave groups was largely through war with the Tamils. One of the groups is actually called *Demalagattaru* or Tamil captives. This body was found chiefly in a few villages of the western and southern provinces. (Pridham, vol. 1, p. 241.)

In addition to the slave castes there were several groups of obscure origin, such as the *Palleru* or *Pallaroo,* bandits and freebooters living in woods and caverns; the *Raadayo,* or Comb-makers; the *Hirawas,* or Sieve-makers; and the *Indrajaliko,* or Conjurers. Pridham (*ibid.*) names certain obscure castes concerning which little is known, such as the *Yaka Daru,* or Devil-worshippers; *Kontayo,* or those who carried the

frame upon which the king's palanquin was placed when he traveled; the *Pidaynidanno*, or Offering-makers to devils; the *Gauraykawallu*, or Village-watchmen; and the *Kappuwo*, or Temple watchmen.

SMITHS AND ARTIFICERS

The workers in metals are called by the following terms, according to Upham (vol. 3, pp. 340–342): *Cammakarayo*, or workers in copper, brass, and silver (i.e., workers in metal); *Suwannakarayo*, workers in gold; *Ayokarayo*, workers in iron; *Achariyo* (*Guruwarayo*), masters; *Nawankaranno*, makers of new things; *Nawandanno*, knowers of the art of making new things out of old; *Lokuruwo*, founders or makers of vessels with melted lead; and *Cammaro* (*Camburo*), a term of reproach because they took employment from high and low (*Kamburanawa* meaning subject or slave). Upham goes on to differentiate the carpenters who, he thinks, are possibly a distinct group as *Waduwo*, enhancers of value, and *Tachakayo*, i.e., smoothers or planers.

According to Coomaraswamy's account (p. 54) the artificers were split into a higher division called *Gallado* and a lower division called *Vaduvo*, between which there could be no interdining or intermarriage. The *Gallado* included architects, painters, goldsmiths and silversmiths, brass-repoussers, ivory-carvers and wood carvers, while the *Vaduvo* included carpenters, wood and ivory turners, blacksmiths, damasceners, stone-carvers, and lac-workers. (Pridham, vol. 1, p. 237, also gives subdivisions.)

Achari was a general term meaning masters or teachers of the arts, and this was frequently applied to the Smiths. Occasionally the term *Gurunnehela*, or teacher, was used for them because of their claimed descent from Brahmans who are teachers, according to Coomaraswamy.

One interesting group discussed by Coomaraswamy (p. 215) were the *Iwaduwo*, or lac-workers, formerly arrowmakers. The two lac-producing insects in Ceylon are both different from those occurring in India. The Ceylonese species are *Tachardia albizzae* (Green), occurring on the acacia, and *Tachardia conchiferata* (Green), occurring on euphorbiaceous plants. Some Indian lac has been imported into Ceylon for a long period. The native work in this substance was carried on at South Matura and in the lowlands near Tangalla in recent years.

The blacksmiths, or *Achari*, supplied nails for roofing houses, for hinges, locks, keys, kitchen utensils, agricultural implements, tools for felling and working timber, areca nut cutters, chunam or lime boxes, and for ear and tooth picks. The last four items were *penum*, *deccum*, or presents for chiefs. The braziers, or *Lokuruwo*, mended all brass and copper vessels of the temples and took part in the services of the other Smiths. (A. A. Perera, 1917, App. p. iii, Badal-Panguwa.)

Silversmiths and goldsmiths worked for the proprietors in their special craft when required and in temples. They mended and polished sacred vessels, did engraving and carving, decorated the car of the *deviyo* or god, remained on guard during the *Perahera* ceremony, attended at the *Kaphitawima*, and supplied the silver rim of the *Ehala-gaha*. Their *penum* or dues consisted of silver rings, betel boxes, and ornamental arrowheads. (Perera, *ibid.*)

The *Sittaru* was a tenant of the Smith caste who mended and kept in repair the images and paintings in the temples. He also supplied ornamental sticks as handles for lances, flags, walking sticks and betel trays. (Perera, *ibid.*, 1917, *Sittara.*)

The *Navandanna* artificers carried a flag with a device of an ape on it, which was called *anumanta* after Hanuman the Monkey god. At festivities they had hangings of white calico. In general practice the Smiths were permitted to sit on stools, which none of the inferior castes might do. In consideration of the value of the services of the Smith he was often allocated a large expanse of fertile land. Men of the caste were entitled to wear the cloth below the knees and the women the *ohoriya* cloth thrown over one shoulder but separate from the regular cloth. (Perera, *ibid.*; see E. W. Perera, pp. 21–22.)

Certain names were peculiar to the Smith caste, and some of their lore bore witness to

Tamil families of the sixteenth and seventeenth centuries. The men were frequently called *Jiwan* and *Vijendra*, while the women were styled *Nachchire* or *Nachchilli*, and by inferiors *Etana*. The goldsmiths, alone of the Kandians other than the Vellalas, held slaves. (Codrington, p. 222.)

The *Kottal-Badda*, or Artificer Department, was organized for Smiths in each district of the Kandian Kingdom. The royal goldsmiths and silversmiths formed a close corporation known as the *Pattal-hatare*, or the Four Workshops, all others being village Smiths. (*Ibid.*)

The costumes of the headmen of the Smith and Washermen castes were much alike. The *Mahavidahns* and *Mahavidahn Mohandirams* wore a cloth or linen coat, with silver buttons and loops, sword with hilt and scabbard of silver, and a plate of tortoise shell on the scabbard, a belt or ribbon embroidered with flowers and gold and silver thread. The *Arrachies* wore a linen coat with silver buttons and silk loops; sword hilt of horn, embellished with silver, the scabbard of horn or wood and with silver bands; and the belt of plain colored ribbon. The *Canganies* wore a linen coat with horn or covered linen buttons, a sword hilt of horn, the scabbard of horn or wood; three copper bands; and a plain ribbon belt. (Bennett, pp. 99–100.)

The *Yamanna* iron-smelters were required to give a certain number of lumps yearly as part of their services and also to burn charcoal for the forge, to carry baggage, and assist in field work and at Yak and Bali ceremonies. They put up the *Talimana* or pair of bellows for the Smith, but they were of *Paduwo* origin and not members of the Smith caste. (A. A. Perera, 1917, App., p. xxiv, *Yamanna*.)

Less than 4 percent of the Kandian population now appear to belong to the Smith caste if present occupations are any guide. The number of persons belonging to this caste, however, undoubtedly is greatly in excess of the number of those still practicing the ancient craft. It is conjectured that perhaps 10 percent of the population of Kandy during the eighteenth century were Smiths and their dependents and that perhaps one-half of these were *Navandanno*. (Coomaraswamy, p. 54.)

The following occupations were pursued by 20 members of the *Navandanno* group in the "Hue and Cry" records: goldsmith 8, cultivator 5, cooly 3, carpenter 2, silversmith 1, and blacksmith 1. The census figures for Sinhalese carpenters are: 1881, 12,648; 1891, 39,179; 1901, 56,143. The corresponding figures for masons were: 1881, 1,765; 1891, 6,850; 1901, 13,088. The figures given for blacksmiths were in 1881, 3,185 and in 1891, 10,298. Finally, the figures for goldsmiths and silversmiths were in 1881, 3,764; 1891, 11,469; and 1901, 14,361.

It is notable that the goldsmiths had particular quarters in the large cities and certain streets were reserved to them.

The subdivisions of the Smith caste are as follows: (1) Architects, *Galladdo* (Coomaraswamy); (2) Arrowmakers and Lacworkers, *Ee waduwo* (Bennett) or *Vaduvo* (Coomaraswamy) and *Iwaduwo* (Valentyn); (3) Artificers, *Nawandanno* (Armour), *Nawaymiyo* or 9 services (Bennett), *Nayide* (Parker) and *Naides* (Perera); (4) Blacksmiths, *Kamburo* or *Achari* (Armour, Perera, Pridham), *Achiary* (Valentyn); (5) Brass-founders, Repoussers, or Braziers, *Lokooroowo* (Armour), Braziers or *Lokoruwo* (Perera), Brass-founders (Pridham), Brass-repoussers (Coomaraswamy), *Lacuruwo* or Smelters (Valentyn); (6) Carpenters, *Waduwo* (Armour, Valentyn); (7) Damasceners, part of *Vaduvo* (Coomaraswamy); (8) Goldsmiths, *Tarahallo* (Armour), *Ranhallo* (Bennett, Pridham), part of *Gallado* (Coomaraswamy), *Ridiceto Ancarao* or Gold and silver inlayers (Valentyn); (9) Lapidaries, *Galwaduwo* (Bennett, Pridham); (10) Masons, *Galwadoowo* (Armour); (11) Painters, *Hittaroo* (Armour), *Sittaru* (Bennett, Perera, Pridham), *Sittereo* (Valentyn), part of *Galado* (Coomaraswamy); (12) Sculptors, *Galwaduwo* (Pridham, Valentyn), Stone-carvers or *Vaduvo* (Coomaraswamy); (13) Silversmiths, *Badaalo* (Armour), *Badallu* (Perera), *Baddallo* (Valentyn); (14) Solderers of metal, *Yamanu* (Bennett); (15) Turners, ivory and wood cabinetmakers, *Liyana waduwo* (Bennett, Pridham), *Adatketeancarao* (Valentyn);

miscellaneous, *Hommaru* or Carcass-removers and Skin-dressers (Bennett, Pridham), *Ratneenderecarao* or Jewellers (Valentyn).

TAILORS

The Tailors, like the Barbers, were a luxury caste for the Sinhalese. There were several terms for this group, as noted by Upham (vol. 3, p. 342), namely: *Tunnawayo*, or weavers (sewers) of pieces; *Sochikayo*, or workers with the needle; *Sannawliyo*, makers of cloth armor; *Mahanno* (*Mananno*), or sewers; and *Hannalio* (*Hannawli*).

Washermen washed for them but would not eat with them, and they did not enjoy the privilege of white linen unless by special permission of the Kandian king. The caste was a small one and was employed principally by the royal palace for embroidery work and by the large Hindu *Dewalas* or temples and Buddhist *Wiharas* where as tenants they sewed and stitched the sacred vestments, curtains, and flags. They assisted in decorating these establishments and were responsible for the manufacture of the gorgeous costumes worn by the king and court in return for which land was allowed them. (Pridham, vol. 1, p. 238; A. A. Perera, 1917, App. p. viii, *Hannaliya*; Coomaraswamy, p. 237 ff.)

According to the census there were 3,465 Sinhalese tailors in 1881, 1,716 in 1891, and in 1901 approximately 6,803.

TODDY-DRAWERS

The Toddy-drawers, or *Chandos*, have the following synonyms, according to Upham: *Sondikayo*, or producers of lust (from Sondamakaya, who first discovered toddy); *Maggawikayo*, or vendors of intoxication; *Surawbeejayo*, i.e., toddy-makers or producers of good taste (referring to their sale of toddy to bakers); *Madinno*, i.e., pruners of trees; *Surawo*, gives of pleasant taste; and *Durawo*, producers or givers of the evil-producing taste. (Upham, vol. 3, pp. 344–345.)

This caste was employed in collecting the sweet juice or toddy from the decapitated flower stalk of the coconut palm, kitul palm, and other trees for the purpose of fermentation. Since use of intoxicants is contrary to Buddhist precept, the Toddy-drawers' calling is confined to a very few families of the interior. (Pridham, vol. 1, p. 237.)

There were a number of subdivisions of the Toddy-drawer caste, according to Bennett, Pridham, and Valentyn (see data below). The highest grades of this caste, according to Valentyn (*in* Philalethes, p. 327 ff.) were the elephant-tamers, who had the right of using white linen or calico and possessed a flag with a red lion on the middle of a white background, along with other distinctions from which inferior sections were barred. Dress of the headmen is described by Bennett (p. 99). (See also E. W. Perera, p. 21.)

The "Hue and Cry" data show the following occupations as pursued by 47 Toddy-drawer people: coolies 23, cultivators 13, toddy-drawers 6, and servants 5. The census of Sinhalese Toddy-drawers listed 2,604 in 1881, 9,857 in 1891, and 11,836 in 1901.

The principal subdivisions of the Toddy-drawers are: (1) Blacksmith helpers, *Ackerammo* (Valentyn); (2) Carriage-makers, *Rata Karayo* (Pridham); (3) Cowherds, *Pati Karayo* (Bennett, Pridham); (4) Dancers, *Kuttadi* (Bennett, Pridham), *Cutany Wolle-etto* or *Arambeo* (Valentyn); (5) Drummers, *Agunmady* (Valentyn); (6) Elephant-feeders, *Pannayo* (Bennett); (7) Knife-carriers, *Niello* (Valentyn); (8) Laborers, *Duravo* or *Chando* (Bennett, Pridham, Valentyn); (9) Rice-sacrificers, *Balibattu* (Bennett, Pridham); (10) Riders of elephants, *Magul Duravo* (Pridham, Valentyn); (11) Servants, *Aynadi* (Bennett, Pridham), *Usanno* (Valentyn); (12) Timber-fellers, *Porawa Karayo* (Bennett, Pridham); (13) Toddy-drawers, *Hari duravo* or *Nattambu* (Bennett), *Hari Duravo* or *Nallambu* (Pridham), *Nattambovo* (Valentyn); (14) Washermen, *Hiwattayo* (Bennett, Pridham); miscellaneous, *Solil Karayo* or particular services (Pridham), *Weedy* and *Cottu* (Valentyn).

TREE-CUTTERS

The *Heeri*, or pioneers, were a small caste. They had a vidane, or chief, and their office was to fell all kinds of trees, to carry

ammunition in war, and to act as pioneers in clearing the way for troops. They did not enjoy the privilege of wearing white linen, and a particular caste called the *Gangavos* washed for them. (Valentyn, in *Philalethes*, p. 331.) The census enumerated 309 Timber-fellers in 1881 and 258 in 1891.

WASHERS

The following are the names given by Upham (vol. 3, pp. 342–343) for the Washerman caste; *Ninney Jakaya*, restorers; *Rajakayo* or *Radau*, removers of dirt; *Paihara Haliyo*, cloth cleaners; *Paidiyo* or takers of payment; and *Hainayo* or *Snaihayo*, beloved persons (referring to their washing the foul linen of little children and thereby obtaining their affection).

The accounts concerning the Washer caste are rather confusing inasmuch as the identity of the different washermen groups and their status relation to each other is not indicated. Apparently the *Radaw* (*Henaya* or *Henawlaya*) were the washers for the *Goigama* and other castes of high status such as sections of the Fishers, Toddy-drawers, etc. Below the *Radaw* were at least three other washer castes, namely: (1) *Hinniwo* or *Hinawa*, who washed for Cinnamon-peelers primarily and also for Smiths, Toddy-drawers, Potters, Tailors, Fishers and Scavengers; (2) *Gangavo*, primarily washers for Tree-cutters and Dancers; and (3) *Pali*, *Paliyo*, or *Apullanna*, washers primarily for low castes such as Lime-burners, Palanquin-bearers, Barbers, Drummers, and Jaggery-makers. In addition, there appears to have been still another group of washers, the *Tarumpar*, who worked for outcastes. Thus it seems evident that the caste status of their clients was reflected in the status of the different Washer groups.

The Washers were a fairly large caste and paid for their land in one-twentieth of its produce in rice. They were said to possess great powers as arbiters in cases of violation of social etiquette or custom, and their refusal to wash the clothes of objectionable persons constituted a form of social ostracism. Washers were occasionally officials at Yak or demon ceremonies, and Parker has recorded some of their songs sung while at work. Paddy was often used to pay them for their services. The term *Henaya* was used in polite address and means a cleaner. (Pridham, vol. 1, pp. 238–239; Knox, in *Philalethes*, pp. 136–137; A. A. Perera, 1917, App. p. xix, *Rada-Baddara-Rajakariya*.)

The dress of the females of this caste consisted of two short cloths, one wrapped around the loins and the other thrown over the shoulder. None of the Washers was allowed to wear white linen. (Knox, *ibid.*) The *Radaw* could eat with Fishers and Toddy-drawers but could not eat with Tailors, Potters, and Barbers, nor could they go to their festivals even though they might wash for them. They washed also for themselves.

They were said to use lye in their washing. They set a pot containing seven to eight gallons of water over the fire and then laid the dirty clothes on top. The steam of the water went through the clothes and scalded them. Afterwards they were taken to the river and flapped against the rocks until clean. (Knox, *ibid.*) A square representing the stone on which the linen was bleached served as a symbol on their flag. (E. W. Perera, p. 37.)

The duties of the Washers consisted in furnishing of white cloth to spread on the ground at ceremonies; to line rooms and cover chairs whenever the Kandian king or his chiefs were expected; to wash at periodic intervals clothes, curtains, flags, and temple vestments; to decorate temples and homes at weddings and ceremonies; to supply carpets and bathing costumes; and to attend the manorial lords on journeys carrying torches of wick and tow. (Coomaraswamy, p. 26; A. A. Perera, 1917, App. p. xix, *Rada-Baddara-Rajakariya.*) The families who washed for the court had their land free for that service. They were not required to wash for any of the superior castes without payment or to degrade themselves by washing for those beneath themselves. At the New Year ceremonies the Washer received in addition to sweetmeats and rice a coin from every member of the family. The coin was tied up in a cloth delivered for washing. At funerals and puberty ceremonies the Washer is entitled to

certain of the clothing used, the clothes not being burnt on the funeral pyre. For details of the dress of the caste headmen see Bennett, pp. 99–100.

The "Hue and Cry" data indicate that out of 36 persons of Washer caste 14 were following that occupation, 6 were cultivators, and 16 were unrecorded or miscellaneous. According to the census there were 12,601 Sinhalese washermen in 1881, 27,466 in 1891, and 29,749 in 1901.

CONCLUSION

The picture herein presented of Sinhalese castes may seem to be somewhat confusing in detail, yet there are certain integrating factors in the system that call for notice.

First, there was the formerly existing system of *rajkariya* or fixed economic services, which were required of each caste in return for its land tenure. These services, each of which was peculiar to the single caste, were rendered to the king, the landlord, or the proprietary temple. The local village or caste headman and the village council were responsible for the performance and maintenance of these duties as royal or local officials. The departmentalization of the government of the native Kandians assigned to each caste specific duties within a section of the political hierarchy. When new services were required new castes were often imported from India to perform them. The disposition of duties and assignment of caste functions constituted a royal prerogative but were limited by customs and traditions of the castes themselves. Thus there existed a complete system of economic exchange between villages, each of which specialized in its particular caste occupations.

Second, a pattern of exploitation of the natural environment becomes apparent in the various caste divisions. The majority caste was the Agriculturist, or *Vellala*, who specialized in the exploitation of the rice-fields of the Island. Other castes such as the Potters and Iron-miners specialized in the extraction and use of inanimate mineral substances, while still others such as the Fishers and Lac-collectors exploited the animal resources. As a result of this specialization there occurred a geographical segregation of caste villages and of urban caste quarters by means of which specialization could be maintained in exclusiveness and without interference from the outside. The manner and the matter of exploitation elevated or debased the social station of the various castes, the Farmer being of high status, the Scavenger of low.

Third, as Hocart (1935, 1936) has shown so ably in his writings on the subject, a group of ritualistic functions assigned to each caste made the services of that caste indispensable to the community generally and to each of the other related castes individually. Thus the Washer was necessary in the purification of clothing from the pollution of menstrual blood and for the performance of rites of marriage; the Barber was necessary for funeral services; the Tom-tom-beaters were needed for Devil exorcism; and the Jaggery-maker cook for temple feasts. The various washer castes reflected the standing of their respective clients and furnished a parallel hierarchy of ceremonial ministrants who buttressed and reinforced the hierarchy of castes proper. A similar situation exists in India where the various Brahman groups are correlated with the social status of their clients and parallel the caste ladder of ranks. The annual processions and seasonal ceremonies in which the Tomtom-beaters and Dancers participated likewise reinforced and reiterated the social priorities of specific caste groups. The repetition of the great ceremonies at specific times of the year helped to perpetuate the social order and peculiar functions of some of the castes and also affected the other groups. The marriage rites, perhaps more important in some respects than any of the others, required the participation of special-service castes even though the rite itself was generally within the single caste group.

Fourth, for each of the castes there was always a certain degree of occupational latitude or elasticity of function. The tasks involved in cultivation were performed by almost all the non-Cultivator castes as well as being a major function of the latter. Each of the non-cultivator groups, how-

ever, was regarded as lower in status and more restricted in occupational choices than the Cultivators. At the bottom of the social scale there was also a latitude of occupational choice, since the *Rodiyas* and *Kinneras* were forced to supply their own barbers, doctors, soothsayers, and officials for demon ceremonies. Each caste, in fact, tended to develop a hierarchy of occupations within its own ranks, and we hear of higher and lower degrees of Cultivators, Fishers, Smiths, Toddy-drawers, Weavers, and Cinnamon-peelers.

Fifth, in explaining the threads underlying Sinhalese caste it is necessary to call attention to certain psychological tendencies apparently shared with the people of India proper. These tendencies include *(a)* a feeling for classification and arrangement in neat logical sequences of all the facts and objects of existence, including human social groupings; *(b)* a craving for order and established precedence expressing itself in a priority system for allocating goods and services to those castes whose functional value is held higher than others; and *(c)* a fear of pollution or contamination shared by Hindu and Buddhist alike, which is evidenced in the avoidance of low-caste impurity by frequent use of new pottery or by use of clothes cleaned by the Washer. The Potter, Washer, and Scavenger, since they removed the impurities of life, seemed to acquire thereby a certain impurity themselves. The caste having to do with life processes and growing, the Cultivators, ranked highest, while the Scavengers and Executioners, concerned with death, were at the bottom of the social scale.

Hocart maintains that each of the Sinhalese castes, as well as those of India proper and other parts of the world, constituted a priesthood with a peculiar ritualistic function of its own. His comparisons of other systems with the Sinhalese, extending from ancient times to the present, from Europe to Polynesia, have brought the caste system of Ceylon into focus with reference to the rest of the world. One does not have to accept unreservedly his generalizations, but it is worth while to read him for his fertility of ideas and helpful logic in untangling the mass of apparently chaotic and confusing practices associated with caste.

The foregoing summary represents the gist of the material at present available in libraries and bibliographies on the subject of Sinhalese castes. It is evident that there is a considerable need for field work and further investigation of this subject. The deficiencies can be summed up in the following order.

(1) There is practically a complete lack of censuses of Sinhalese castes, and although such censuses may have been taken at some time in the nineteenth century no record seems to have been made of it. The occupational census is of very little value in this regard.

(2) There are very few illustrations of Sinhalese caste types in the literature, and these suffer from lack of identifying captions as to whether they are Sinhalese or Tamil and do not show physical types. Pictures of Jaggery-makers, Palanquin-bearers, and Lime-burners in particular seem difficult to find. In Appendix V of this paper a list of illustrated material on the castes is given. Anthropometric data on the different castes are needed in addition to good photographic records.

(3) There seems to be dearth of material on the internal structure of the Sinhalese castes. Though we are told in a general way that each village had a council and a caste headman, little is really gathered regarding the actual operation of the system. Can we say that there are caste panchayats or other institutions similar to those of India proper?

(4) There are no records of community surveys including caste data along with other relevant social facts concerning residence, segregation, present occupational activities, incomes, endogamy, and tendencies toward disregard of caste rules. Even a single instance of such a survey would go far toward throwing light on the present social conditions of the Sinhalese castes.

(5) There are no facts relevant to the effects of the European system on the native economy, especially as regard the caste obligations and how the transition was made from one to another. If this story were ever

certain of the clothing used, the clothes not being burnt on the funeral pyre. For details of the dress of the caste headmen see Bennett, pp. 99–100.

The "Hue and Cry" data indicate that out of 36 persons of Washer caste 14 were following that occupation, 6 were cultivators, and 16 were unrecorded or miscellaneous. According to the census there were 12,601 Sinhalese washermen in 1881, 27,466 in 1891, and 29,749 in 1901.

CONCLUSION

The picture herein presented of Sinhalese castes may seem to be somewhat confusing in detail, yet there are certain integrating factors in the system that call for notice.

First, there was the formerly existing system of *rajkariya* or fixed economic services, which were required of each caste in return for its land tenure. These services, each of which was peculiar to the single caste, were rendered to the king, the landlord, or the proprietary temple. The local village or caste headman and the village council were responsible for the performance and maintenance of these duties as royal or local officials. The departmentalization of the government of the native Kandians assigned to each caste specific duties within a section of the political hierarchy. When new services were required new castes were often imported from India to perform them. The disposition of duties and assignment of caste functions constituted a royal prerogative but were limited by customs and traditions of the castes themselves. Thus there existed a complete system of economic exchange between villages, each of which specialized in its particular caste occupations.

Second, a pattern of exploitation of the natural environment becomes apparent in the various caste divisions. The majority caste was the Agriculturist, or *Vellala*, who specialized in the exploitation of the rice-fields of the Island. Other castes such as the Potters and Iron-miners specialized in the extraction and use of inanimate mineral substances, while still others such as the Fishers and Lac-collectors exploited the animal resources. As a result of this specialization there occurred a geographical segregation of caste villages and of urban caste quarters by means of which specialization could be maintained in exclusiveness and without interference from the outside. The manner and the matter of exploitation elevated or debased the social station of the various castes, the Farmer being of high status, the Scavenger of low.

Third, as Hocart (1935, 1936) has shown so ably in his writings on the subject, a group of ritualistic functions assigned to each caste made the services of that caste indispensable to the community generally and to each of the other related castes individually. Thus the Washer was necessary in the purification of clothing from the pollution of menstrual blood and for the performance of rites of marriage; the Barber was necessary for funeral services; the Tomtom-beaters were needed for Devil exorcism; and the Jaggery-maker cook for temple feasts. The various washer castes reflected the standing of their respective clients and furnished a parallel hierarchy of ceremonial ministrants who buttressed and reinforced the hierarchy of castes proper. A similar situation exists in India where the various Brahman groups are correlated with the social status of their clients and parallel the caste ladder of ranks. The annual processions and seasonal ceremonies in which the Tomtom-beaters and Dancers participated likewise reinforced and reiterated the social priorities of specific caste groups. The repetition of the great ceremonies at specific times of the year helped to perpetuate the social order and peculiar functions of some of the castes and also affected the other groups. The marriage rites, perhaps more important in some respects than any of the others, required the participation of special-service castes even though the rite itself was generally within the single caste group.

Fourth, for each of the castes there was always a certain degree of occupational latitude or elasticity of function. The tasks involved in cultivation were performed by almost all the non-Cultivator castes as well as being a major function of the latter. Each of the non-cultivator groups, how-

Clark, Ency. Brit.); Fish-curers (Perera) *Karawo* (Armour, Bennett; Chitty, Cordiner, Davy, Encycl. Metrop., Guenther, Hue and Cry, Janavamsa, Jancigny, Joinville, Niti Nighanduwa, Nordhoff, Parker, Perera, Pridham, Queyroz, de Saram, Schmidt, Schouten, Selkirk, Upham, Valentyn); *Keulhi* (Dharmaratne); *Ouagouri kayo* (Gauttier).

11. *Grass-cutters*

Grass-cutters (Barrow, Upham); Fodderers or Fodder-providers (Perera); *Pannayo* (Armour, Davy, Guenther, Hue and Cry, Janavamsa, Jancigny, Selkirk, Schmidt, Perera, Pridham); *Pannaduras* (Bertolacci); *Panna duraya* (Perera); *Hinnawo* (Niti Nighanduwa).

12. *Hunters*

Dodda weddahs (Davy, Jancigny, Pridham); *Vedda* (Gauttier, Janavamsa, Hue and Cry, Joinville, Queyroz).

13. *Jaggery-makers*

Jaggery-makers (Barrow, Bertolacci, Encycl. Metrop., Knox); Cooks (Bennett); Cooks or porters (Cordiner, Nordhoff); Molasses-makers (Perera); *Jagreros* (Armour, Cordiner, Encycl. Metrop., Joinville, Nordhoff, Ribeiro, de Saram); *Hangarammo* (Armour, Knox, Niti Nighanduwa, Valentyn); *Hakuro* (Bennett, Chitty, Davy, Guenther, Hue and Cry, Janavamsa, Jancigny, Perera; Pridham, de Saram, Schmidt, Selkirk, Upham); *Wahumpura* (Hue and Cry); *Kande duraya* (Perera).

14. *Leather-workers*

Sandal-makers (Bennett, Pridham); Shoemakers (Chitty, Ribeiro, Upham, Valentyn); Tanners (Cordiner); *Homaru* (Armour, Bennett, Chitty, Ribeiro, Valentyn); *Somaru* (Bennett, Cordiner, Janavamsa, Nordhoff, Pridham, Upham); *Nagaran Karas* (Bertolacci); *Jawammu?* (Guenther).

15. *Lime-burners*

Lime-burners (Barrow); *Chunam*-burners (Bennett, de Saram, Upham); Lime- and mortar-makers (Bertolacci); *Hunno* (Armour, Chitty, Cordiner, Guenther, Hue and Cry, Janavamsa, Joinville, Nordhoff, Perera, de Saram, Schmidt, Selkirk, Upham, Valentyn); *Hurma* (Bennett, Jancigny); *Hunu durayo* (Niti Nighanduwa, Perera); *Hunu badde* (Davy, Jancigny, Pridham); *Chinambero* (Valentyn).

16. *Mat-weavers*

Mat-weavers (Barrow); *Kinnaru* (Armour, Cordiner, Guenther, Hue and Cry, Knox, Niti Nighanduwa, Nordhoff, Parker, Perera, de Saram, Schmidt, Selkirk, Upham); *Hinnarayo* (Bennett); *Hinnawo* (Bennett); *Kinnera badde* (Davy); *Kinnaya* (Encycl. Metrop.), *Kinnarayo* (Janavamsa); *Kinneru badde* (Jancigny, Pridham); *Kinnava* (Joinville); *Kirinerahs* (Knox); *Hiene Jaty* (Valentyn).

17. *Outcastes*

Outcastes (Barrow, Clark, Percival); Skinners (Bennett); Beggars (Knox); Leather- and rope-makers (Upham); *Rodiya* (Armour, Bennett, Chitty, Cordiner, Davy, Dharmaratne, Encycl. Metrop., Guenther, Hue and Cry, Janavamsa, Jancigny, Joinville, Knox, Niti Nighanduwa, Nordhoff, Parker, Perera, Pridham, de Saram, Schmidt, Selkirk, Upham); *Roriz* (Queyroz); *Gasmundo* (Jancigny, Schmidt); *Antere Jaty* (Valentyn); *Gattaru* (Cordiner, Encycl. Metrop., Jancigny, Pridham, Schmidt); *Shenders* (Cordiner, Nordhoff).

18. *Palanquin-bearers*

A. Palanquin-bearers (Barrow); *Paduwo* (Armour, Bennett, Bertolacci, Chitty, Cordiner, Davy, Guenther, Hue and Cry, Jancigny, Joinville, Knox, Nordhoff, Perera, Pridham, Queyroz, Ribeiro, de Saram, Schmidt, Selkirk, Upham, Valentyn); Porters (Chitty); Baggage carriers (Encycl. Brit.); Carriers (Guenther).

B. Executioners (Barrow, Nordhoff, Niti Nighanduwa, Selkirk, Pridham, Cordiner); Hangmen (Guenther, Schmidt); Scavengers (Bennett, Encycl. Brit.); House-wall builders (Bennett, Upham); House-builders (Guenther); Carcass-removers (Guenther, Upham, Schmidt); *Batgama* (Dharmaratne, Hue and Cry, Schmidt); *Batgam duraya* (Perera); *Batgam Paduvo* (Niti Nighanduwa); *Galahayo* (Armour, Guenther, Bennett, Janavamsa, Gauttier, Schmidt, Selkirk); *Gahalega* or *Bedea* (Cordiner, Nordhoff, Upham); Duraya (Parker).

C. Iron-smelters (Armour, Pridham, Schmidt); *Yamannu* (Armour, Ribeiro, Schmidt).

19. *Potters*

Potters (Ballou, Barrow, Clark, Dharmaratne, Ency. Brit., Knox, Percival, Perera, Ribeiro); Tile-makers (Perera); *Badahelayo* (Armour, Davy, Guenther, Hue and Cry, Niti Nighanduwa, Parker, Perera, Pridham, de Saram, Schmidt, Selkirk, Upham); *Kumbalu* (Bennett, Chitty, Cordiner, Janavamsa, Nordhoff, Selkirk, Valentyn).

20. *Sieve-makers*

Hirawa (Armour, Cordiner).

21. *Slaves*

Wallu (Bennett); *Daasayo* (Bennett, Gauttier); *Nallovas* (Schouten).

22. *Smiths*

Smiths (Ballou, Barrow, Bertolacci, Encycl. Brit., Knox, Parker, Percival, Perera, Ribeiro, Upham); Mechanics (Cordiner); Artificers (Valentyn); *Nawandanno* (Armour, Chitty, Hue and Cry, Joinville, Niti Nighanduwa, Perera, Upham, Valentyn); Nawaymiyo (Bennett); *Kamburu* (Cordiner, Janavamsa, Nordhoff); *Achari* (Davy, Gauttier, Guenther, Jancigny, Parker, Pridham, Schmidt, Selkirk); *Vaduvo* (Janavamsa); *Kottal badde* (de Saram); *Badalo* (Selkirk, Hue and Cry).

23. *Tailors*

Tailors (Perera, Upham); *Hanali* (Armour, Bennett, Chitty, Davy, Janavamsa, Jancigny, Niti Nighanduwa, Pridham, de Saram, Schmidt).

24. *Toddy-drawers*

Toddy-drawers (Barrow, Bertolacci, Perera), Coconut-climbers (Clark); Elephant-tamers (Upham); *Durawo* (Armour, Bennett, Chitty, Cordiner, Ency. Metrop., Hue and Cry, Janavamsa, Jancigny, Joinville, Niti Nighanduwa, Nordhoff, Perera, Pridham, de Saram, Schmidt, Selkirk, Upham, Valentyn); *Chando* (Armour, Bennett, Cordiner, Davy, Encycl. Metrop., Guenther, Jancigny, Pridham, Queyroz,, de Saram, Schmidt, Selkirk, Upham, Valentyn); *Madinno* (Davy, Parker, de Saram); *Sourave* (Joinville).

25. *Tree-cutters*

Wood-cutters (Chitty); Woodsmen (Chitty); Pioneers (Chitty); Shooters (Upham); *Palleru* (Cordiner, Chitty, Jancigny, Niti Nighanduwa, Pridham, Queyroz, de Saram, Upham, Valentyn); *Heeri* (Chitty, Valentyn); *Porokara* (Hue and Cry); *Hunna kotanno* (Chitty).

26. *Washers*

A. Washermen (Armour, Ballou, Barrow, Bennett, Bertolacci, Clark); Washers (Encycl. Brit., Guenther, Joinville, Percival, Perera, Ribeiro, de Saram, Schmidt, Selkirk, Upham, Valentyn); *Radav* (Armour, Bennett, Chitty, Cordiner, Davy, Ency. Metrop., Guenther, Hue and Cry, Janavamsa, Jancigny, Joinville, Knox, Niti Nighanduwa, Nordhoff, Parker, Perera, Pridham, de Saram, Schmidt, Selkirk, Upham, Valentyn); *Dhobies* (Dharmaratne, Guenther); *Henayo* (Parker).

B. *Hinawa* or *Hinnevo* (Bennett, de Saram, Perera, Chitty, Upham, Valentyn, Selkirk, Guenther); Washers to Cinnamon peelers (Barrow, Guenther, Perera, de Saram, Selkirk, Upham, Valentyn); Washers for *Naides* (Perera).

C. *Gangavo* (Chitty, Perera, Valentyn); Washers for *Heeri* (Chitty, Valentyn); Washers for *Oli* (Perera, Valentyn).

D. *Pali* or *Apullano* (Armour, Niti Nighanduwa, Jancigny, Chitty, Guenther, Schmidt, Upham, Perera); Washers to *Hunno* (Chitty, Valentyn); Washers to low castes (Barrow, Guenther, Upham); Washers to Scavengers (Bennett); Washers for *Duraya*, Barbers, *Neketto* (Perera); Washers for Jaggery-makers, Lime-burners, Tomtom-beaters, and Palanquin-bearers (de Saram).

27. *Weavers*

Villedurai (Davy, Guenther, Jancigny, Perera, Pridham).

28. *Miscellaneous*

Cattle-keepers (Chitty, Cordiner); Pack-bullock-drivers (Perera); *Hunugambadu* (Chitty); *Gopaliya* (Cordiner); *Gopeloas* (Nordhoff).

APPENDIX II: GLOSSARY OF SINHALESE CASTE NAMES

ABORIGINALS: Veddas.

ACHARI or ACHARIYO: Blacksmiths, sing. Achariya, a blacksmith.

ACHIARY: Achari.

ACKERANNO: Coconut-bark rope-makers and Smiths' assistants; Chando.

ADARMISHTAYO: Unrighteous men or bestial men; Rodias.

ADASSING: Nobility of the Goigama.

ADATKETEANCARAO: Workers in ivory and Cabinet-makers; Smiths.

AGRICULTURISTS: Goigama.

AGUNMADY: Drummers; Chando.

AHLIGUNTHIKAYO: Ceylon gypsies.

AIMADUWO: Arrow-makers.

AMBETTAYO or EMBETTO: Those who live nearby. As ministers of the king's cabinet they were near the royal personage; Panikkayo or Barbers.

ANDI: Beggars (Tamils).

ANGLERS: Kaywalo or Karawe; Dandu-karawo.

ANTERE JATY: Rodias or Outcaste Ropemakers.

APPUHAMY: Descendants of chiefs and headmen, a branch of the Goigama.
APULLANO: Washers to Lime-burners and low castes, Pali or Paliyo.
ARAMBEO: Pagoda-dancers; Chando.
ARCHERS: Dunuwaagely or Karawe.
ARROW-MAKERS: Iwaduwo.
ARTIFICERS: Nawandanno.
ASTROLOGERS: Weavers or Berawayo.
ATODYA-WADAKAYA: Berawayo. Name derived from Atodya, a minister who first appointed them to the duty of Tomtom-beating and who himself made and played on the first timbrel or drum with one head which is called by his name.
AYMBAYTHAYO: Ambettayo or Barbers.
AYNADI: Servants to Duravos; a branch of Duravos.
AYOKARAYO: Workers in iron.
AYTTALAYO: Feeders of elephants.

BAAK-KAYO: Purveyors of food.
BADAHELA OR BADAHELAYO: Coombakarayo or Potters, sing. Badahelaya, a potter.
BADALU: Baddallo, Silversmiths, sing. Badala, a silversmith.
BADA SELLAYO: Possessors of near halls, so called because they burnt their wares in large huts near their dwellings. Potters.
BADDAHALLAYA: Coombakarayo or Potters.
BADDALLO: Silversmiths; Achari.
BADDEMINIHA: Tomtom-beaters (respectful).
BADDO: Rice-makers; Paduwa or Palanquin-bearers.
BADGAMA: Batgammi.
BALIBATGAMAYO: Bali or planet propitiatory ceremonialists; Goigama.
BALI-EDURA: Teachers of Bali ceremonies; Oliya.
BALI TIYANA: One who makes bali images; Oliya.
BALLI BATTU: Rice-sacrificers; Duravos.
BAMMANU: Brahman, sing. Bamuna.
BANDARA WALIYA: Goigama.
BARBARIANS: Rodias.
BARBERS: Panikkayo; Ambettayo, Embettayo.
BARI KAYO: Carriers.
BARRAWABADDE MAHABADDE: Weavers or Tomtom-beaters; Berawayo.
BARUDEL-KARAWO: Fishers who do not use casting nets; Carawo.
BASKET-MAKERS: Sinnawo; Handi.
BATGAMMI, BATGAMAYO OR BATGAMA ETTO: Rice village people; Paduwo or Palanquin-bearers.
BATGAMWELLA: Seeders of royal domain; Goigama.
BEDA OR BEDDA: Vedda.
BERAKARAYA: Tomtom-beater, Drummer.
BERAWA, BERAWAYO, BEREVERAS: Beaters of the baira or tomtom; sing. Berawaya, a weaver.
BERBAYAS: Berawayas.
BETEL-GROWERS: Dalae-Murecarao; Goigama.
BIRD-CATCHERS: Pakai wadi; Karawe or Fishers.
BIRD-SNARERS: Williya; Karawe
BLACKSMITHS: Ranhallo; Achari.
BRAGHMAN: Brahman.
BRAHMANAYO: Brahman.
BRAHMAN WANSAYA, BRAMIN, BRACHMAN: Brahman.
BRASS-FOUNDERS: Lokuruwo; Achari.
BRAZIERS: Brass-founders; Lokuruwo.

CAMBOOAS: Mechanics, carpenters, goldsmiths; Smiths.
CAMBURO, CAMMARO: Derived from Kamburanawa, slaves; Smiths.
CAMMAKARAYO: Workers in copper, brass, and silver; Nawandanno.
CANDALAYO: Scavengers, eaters of unclean food.
CANDEY ETTO OR KANDIANS: Livers in the mountains; Pakuro or Jaggery makers.
CAPPAKAYO: Cutters; Barbers.
CARAWO OR KARAWE: Shore people or dwellers by the shore; Fishers.
CARIAWASSIN OR MAYORALS: Goigama.
CARPENTERS: Waduwo, Danduwaduwo; Karawe or Fishers.
CARREAS: Karawe or Fishers.
CARRIAGE-MAKERS: Rata Karayo; Karawe or Fishers.
CATTAKARAYO: Workers in hard matter or wood. So called because they beat up pieces of wood into pulpy matter, which they used to manufacture mats; Kinnaru.
CHALIAS: People of Chilaw; Cinnamon-peelers and weavers by trade; Halagama.
CHAMMAKARAYO: Skin-dressers; Sanmahanno or Shoemakers.
CHANDA LAYO: Skin-dressers; Candalayo.
CHANDO: Toddy-drawers who extract toddy from Coconut and kitul palm.
CHINAMBERS: Lime-burners or Hunno; Chunna-karayo.
CHIVIAS: Chalias.
CHUNNA-KARAYO: Lime-burners or reducers to powder by burning stones and trees.
CHUNAM-BURNERS: Hunno or Lime-burners.
CINNAMON-PEELERS: Originally imported to Ceylon as weavers, they became peelers of cinnamon bark; Chalias.
CONJURERS: Indrajalikayo.

COOKS: Wahunpurayo or Pakuro, Jaggery-makers.

COOLOOPOTTO: Peeling winnower-makers. This refers to their manufacture of winnowers from peelings of bamboo cane and reed. Sinnawo or Handi (Basket-makers).

COOMBAKARAYO: Potters, named after Coobeya, a first potter.

COOMBELOOAS: Potters.

COOROONDO CARAYA: Cinnamon-peelers; Chalias.

CORNACAS: Elephant-tenders; Couratto.

COURATTO: Elephant-tenders.

COTTU: Chando or Toddy-drawers.

COWHERDS: Pati Karayo; Duravos. Also Gombaducarao division of Goigama.

CROCODILE-TRAPPERS: Kayman wadi; Karawe.

CUBELLO: Coombakarayo or Potters.

CULAWLAYO: Potters or Coombakarayo. So called after Culala, first potter.

CULTIVATORS: Goigama or Vellala agriculturists.

CUMBALLU: Coombakarayo or Potters.

CUTARY WOLLE-ETTO: Dancers in pagodas, etc.; Chando or Toddy-drawers.

DADEWEDDA: Hunters or game procurers; Goigama.

DANCERS: Oliya.

DANDU-KARAWO: Fish only with angling rod of bamboo, anglers; Karawe.

DANDUWADUWO DANDOUADOUYO: Carpenters; Karawe.

DARAWO: Elephant-tamers; Duravo.

DECCUM CARAO: Lime-burners or Hunno who paid a poll tax.

DEMALAGATTERA or DEMALA GATTARU: Tamil slave caste, captives of Sinhalese in war.

DEVAYO: Workers in the kitchen or Hakuru.

DHOBY: Washerman, Radaw.

DIEGARANNO: Collectors of gems from stream beds; Goigama.

DIYALUWO: Water-carriers.

DODDA VEDDAS: Veddas or hunters.

DRUMMERS: Berawayas or Tomtom-beaters and weavers.

DUNUWAAYELI: Archers; Karawe or Fishers.

DURAVE or DURAWE: Producers of evil-producing taste; Chando or Toddy drawers, sing. Durawa.

DURAYA: Palanquin bearers, Paduwas.

ELEPHANT-CATCHERS: Weenawo; Magul Duravo.

EMBETTAYO: Barbers.

EMBETTEO: Barbers.

ETTWALAPANNIKKAYO: Elephant-keepers; Goigama.

EXECUTIONERS: Gahalagambadayo or Paduwa. Also Wadekayo or Karawe.

FAMALE: Workers in iron, miners.

FISHMONGERS: Matwikunanno or Karawe.

FISHERMEN, FISHERS: Karawe or Carawo.

FLOWER GARDENERS: Malcaruwo or Goigama.

GADI: Rodiya (respectful).

GAHALAGAMBADAYO, GAHALAYA, GAHALA PAM: Removers and buriers of corpses and elephant carcasses. Executioners and scavengers; Paduwas.

GALLADO: Artificers of upper division.

GALWADUWO: Lapidaries, stonecutters and sculptors; Achari.

GANGAVO: Washers for Heeri and Olias.

GANITAYO: Counters or calculators. So called because they are astrologers and predicters of the motions of the planets; Berawayas.

GARDENERS: Malcaruwo; Goigama.

GASMANDO: Outcastes or Rodias. Named from a kind of rope made by them for catching elephants. Sing. Gasmanda.

GATTARU: Outcasted members of upper castes by royal action. Descendants of captives, condemned thieves, etc.

GAURAYKAWALLU: Village watchmen.

GEM COLLECTORS: Diegaranno, Goddegarranno; Goigama.

GODDEGARRANNO: Searchers of gems in the soil.

GODE KEWULOO: Fishermen or inlets of the sea or at river mouths. They possessed a peculiar fishing tackle. Karawe.

GOEWANSE: Goigama.

GOI BAMUNO: Cultivating Brahmans; Goigama.

GOIGAMA or GOYIGAMA: Cultivators or Vellala.

GOIGAMA ETTO: Goiyo or Cultivators, rice-village people.

GOIKULAYO: Of the cultivating caste; Goigama.

GOIYO, GOWIYA, GOIGAMA ETTO: Cultivators.

GOLDSMITHS: Nawandanno, Badalo.

GOMBADUCARAO: Peasants who attended cows and supplied king with grain; Goigama.

GONY WAMSAYA: Goigama.

GOPELOOAS, GOPALAYES: Cattle-keepers.

GOYANKARANNO: Dowers or cultivators of rice; Goigama.

GRASS CUTTERS: Pannayo.

GURUNNEHE: Tomtom-beaters (respectful).

GURUNNEHELA: Teachers; Achari.

GURUWARAYO: Masters; Achari.

GURUWO: A mixed caste of Sinhalese and Moors, Moslem in religion.

HADAYO: Plaiters; Sinnawo or Handi.

HAINAWALAYO: Fringe makers; Kinnaru.

HAINAYO: Beloved persons; Radaw or Washers.

HAKURO, HAKKUROO: Jaggery-makers, sing. Hakura.

HALIYO or HALI: Chalias or Cinnamon peelers, sing. Haliya.

HALLAGAMA or HALAGAMA: Chalias or Cinnamon-peelers.

HALUGE: People of the Washer caste.

HANDEE, HANDI, or HENDAYO: Basket-makers. Furnished the royal stores with baskets and winnows. Were thought to be beggars or Rodias by some.

HANDURUWO: Sanduruwo or Hondrews, Gentlemen; Goigama.

HANGAREMA or HANGAREMMU: Sugar-makers from palm sap; Wahunpurayo or Jaggery-makers (respectful).

HANNALI or HANNAWLI: Tailors or Mananno.

HARI DURAVO: Duravos proper.

HAYWAYO: Soldiers; Paduwa.

HEDIDEMALA: Tamil caste name.

HEERI: Pioneers or Tree fellers in war.

HENAWALAYO: Mat-makers; Kinnaru.

HENAYO: Washermen, sing. Henaya.

HENDAYO: Handi or Basket-makers.

HEWAPANNAY: Soldiers or lascoreens; Goigama.

HIENE JATY: Weavers of mats with which they pay poll tax; Kinnaru.

HINAWAH: Washers to Gahalaya or Scavengers.

HINNAWO: Pannayo or Grass cutters.

HINNEVO or HINNIVO, HINNAWO: Washers for Chalias, Jaggery-makers, and Feeders of elephants.

HIRAWA: Sieve-makers.

HIWATTAYO: Washers for Duravos: Duravos.

HOMMARU: Skin-dressers and Scavengers.

HONDREWS HONDURU: Gentlemen; Goigama.

HORU: Thieves.

HULAWALIYA: Rodia headmen.

HUNGARAMMU: Hangarema or Jaggery-makers.

HUNGRAMS: Jaggery-makers.

HUNKIRICARAO: Suppliers of milk; Goigama.

HUNNO: Lime-burners or manufacturers, sing. Hunna.

HUNTERS: Veddas.

HUNU GAMBADU: Peasants who fodder and take care of cattle.

HUNU KATTANNO: Fellers of trees for lime kilns.

INDIMAL-KEULO or KEWULU: Manufacturers of lines and nets from the bark of the coconut tree, which they sell to the Fishers. They use baskets and little nets to catch fish in rivers. They employ the date-tree flower in their festivals, which they call Indimal. They are Karawe.

INDRAJALIKAYO: Conjurors.

INLAYERS OF GOLD AND SILVER: Ridiceto Ancarao.

IRON-FOUNDERS: Yamanayo.

IVORY-WORKERS AND CABINET-MAKERS: Adatketeancarao; Smiths.

IWADUWO: Arrow-makers and Workers in lac; Achari.

JAGGERY-MAKERS: Manufacturers of Jaggery sugar from the sap of trees, Wahunpurayo.

JAGHERERS: Coolies or common porters.

JAGREROS: Jaggery-makers.

JANA CAPANNO: Grass-cutters; Pannayo.

JAWLIKAYO: Workers with nets; Karawe.

JEWELERS: Ratneenderecarao.

KADUL-KARAWO: Sails of the fishing boats of these Fishers are of dark red color and this color is made from a dye extracted from the bark of the cajou tree.

KANDE-MINISSA: Hillmen or Jaggery-makers; Hakuru.

KAPPUWO: Temple watchmen.

KARAWE or KARAWO: Fishermen, sing. Karawa.

KARMANTAKAKARAYA: Workmen; Kinnaru.

KARRANAWIYO: Razor-users; Barbers.

KASALAYO: Throwers-away of dirt; Gahalayo or Scavengers.

KASSAKAYO: Plowers; Goigama.

KAYMAN WADI: Crocodile-catcher; Karawe.

KAY-WATTAYO: Surrounders of water; Karawe.

KAYWULO: Anglers who catch fish only with hook and line; Karawe.

KESBA KARAWAY, KESPE-KARAWO: Subsisters by turtles and tortoises which they catch in a large net; Karawe.

KETTAU JIEWAKAYO, KHETTA JIEWAKAYO: Livers by the field; Goigama.

KIDAWARU, KIDDEAS: Makers of fans to fan corn and cane baskets, lace bedsteads, and stools; Kinnaru.

KINNARU, KINNARAYA: Workers in grass or Mat-weavers, sing. Kinnara.

KINNERA BADDE, KIRINERAHS: Rope- and mat-makers; Kinnaru.

KONTAYO: Carriers of the frame of the king's palanquin.

KOOSTAROGIYO: Lepers and devil dancers.

KSHATRIA: Royal Race.

KSHUDRA: Sudra.

KUMBALLU: Potters, sing. Kumbala.

KURUNDAKARAYO: Chalia, Cinnamon-peelers.

KURUNEKA: Elephant-attendants, Cornacas.

KUNAMMADUVEGAMAYO: Palanquin-bearer headmen; Goigama.

KUTTADI: Dancers; Durawo.

LACURUWO, LOKURUWO: Smelters; Achari.
LAC-WORKERS: Iwaduwo, workers in lac and Arrow-makers.
LAPIDARIES: Galwaduwo; Smiths.
LEAD-FOUNDERS: Lokuruwo.
LEATHER-WORKERS: Sanmahanno, shoemakers.
LIANE or LIYANA WADUWO: Turners; Achari.
LIME-BURNERS: Hunno, those who burn wood, shells, or stones for lime.
LOKURUWO: Brass-founders or Lead-makers, Lacuruwo; Smiths, sing. Lokuruwa.

MADAMEMINIHA: Guruwo (respectful).
MADAN: Madinno.
MADEL KARAWAY: Madel net fishers; Karawe.
MADINNO: Tree-pruners; Chando.
MADUKARAYA: Ropemen; Rodias.
MAGAL (MAGUL) DURAVO: Riders or tamers of the royal elephants; Duravo.
MAGGAWIKAYO: Vendors of intoxication; Chando, also deer-killers.
MAHABADDE or MAHABADDEY-ETTO: People of the Cinnamon caste. From Mahabadde, the great rent, referring to cinnamon as the principal source of revenue; Chalias.
MAHANNO: Sewers; Mananno or Tailors.
MALCARUWO: Derived from Mawlacawrayo, flower-chain makers or garland-makers; flower gardeners; Goigama.
MANANNO: Tailors.
MANDUKARAYA: Rodiya (respectful).
MASKED DANCERS: Oliyo.
MAT-WEAVERS: Kinnaru.
MATWIKUNANNO: Fishmongers; Karawe.
MEEHUDUDAYE WADI: Fishers with nets in the sea only; Karawe.
MILKMEN: Hunkiricurao; Goigama.
MORU-KARAWO: These Fishers use hemp nets to catch skates and extract oil from the latter; Karawe.
MUDALIPERUMA: Goigama.
MUSICIANS: Berewayas or Tomtom-beaters.

NAGARAM KARAS: Leather-workers.
NAHAPIKAYO: Comforters; Barbers.
NAIDE or NÁYIDÉ: A group of inferior artisan castes, namely, Smiths, Potters, Fishers, Toddy-drawers (respectful).
NALAKARAYO: Players upon wood instruments.
NALLAMBU: Toddy-drawers.
NALLOVAS: Unclean slaves and servants of cultivators.
NATTAMBOVO: Chando.
NAWANDANNO, NAWANKARANNO, NAWANDANNAJO: Makers of new things, or goldsmiths, silversmiths, and other metal workers.
NEKATAYO: Astrologers; Berawayas, sing. Nekatiya.
NET AND LINE-MAKERS: Indimal-keulo; Karawe.
NIELLO: Chando.
NETTUKKARAYA: Dancer, a term applied to Rodia women.
NILLEMAKAREYEA or PATTEA: Shepherds; Goigama.
NINNEY JAKAYA: Restorers; Radawa or Washers.

OLIAS: Providers of oil for illumination at night and tenders of elephants.
OLIYO or OLI: Masked dancers; also washers to low castes.
OLLEE or OLI: Carriers of effigies of demons called "Assooriahs" in annual festivals.
OLLIE: Procurers of coal.
OUAGOURI KAYO: Fishers.
ORU KARAWAY: Boat-fishers; Karawe.
OUTCASTES: Rodias.
OUTLAWS: Palleru.

PACHAS: Paduwa.
PADDO, PADDAS, PADIWO: Rice-makers; Paduwo.
PADDUWOO: Erecters of house walls; Paduwo.
PADUWO: Palanquin-bearers, hereditary royal serfs, carriers, sing. Paduwa.
PAIHARA HELIYO: Cloth-cleaners; Radaw.
PAIDIYO: Takers of payment; Radaw.
PAINDA PERUMU: Goigama.
PAINTERS: Sittaru; Smiths.
PAISACAWRAYO, PAIHARO: Weavers of gold and silver thread from Paisecarawa in India. Chalias.
PAISAKARA BRAHMANAYO: Gold and silver-thread-weaving Brahmans; Chalias.
PAKAI WADI: Bird-catchers; Karawe.
PAKURO: Stonemakers, so called by reason of the hard cakes of sugar that they manufacture; Jaggery-makers.
PALANQUIN-BEARERS: Paduwa or Duraya.
PALHORUPADUVO: Robber, Paduwo.
PALI: Washers for low castes.
PALLAROO, PALLARU or PALLERU: Banditti or freebooters in the woods liable to any service; also Washermen to low castes, subdivision of Pali.
PALLY: Washers for Lime-burners, Tomtom-beaters, Jaggery-makers, Paduwo.
PANDITTAYO: Wise men; Potters.
PANIKKAYO: Leaf or foliage cutters; Barbers.
PANIKKILA: Tomtom-beater.
PANIKKIYA: Barber (in lowlands).
PANIVIDAKARAYA: Messenger; Lime-burner.

Pannaderia: Grass-cutter.

Pannakarayo: Leaf-workers or leaf-weavers: Kinnaru.

Pannayo: Named from Pan, a species of high grass which they cut. These are Grass-cutters, leaf-cutters, or leaf-strippers for elephant fodder.

Parava: Bard (Tamil caste).

Pas kulu: Five tribes; carpenter, weaver, washer, barber, and shoemaker.

Pass mehe Karayo: Five performers of services; Karawe.

Pati Karayo: Cowherds; Durawe.

Patteas: Nillemakereyea or Shepherds.

Pattiwala aga: Cowherds; Goigama.

Pawtges: Paduwa.

Payinda: Messenger; Hunno or Lime-burner.

Peasants: Goigama.

Peesakaraye: Carriers of Palanquins.

Pesakarayo: Chalia.

Pidaynidanno: Sacrificers to devils.

Pioneers: Heeri.

Poddah: Husbandmen and soldiers.

Pookoosayo: Removers of city dirt; Gahalayo.

Porawakkara Karaway, Porawawa Karayo: Timber-fellers or Woodsmen; Durawo; also Karawe.

Porokara: Axmen; Goigama.

Porters: Paduwo.

Potters: Coombakarayo, Badahelayo.

Priests: Pidaynidanno.

Pupawelendo: Cake-sellers.

Pupphachaddokayo: Casters away of flowers; Gahalayo.

Raawelendo: Toddy-drawers.

Radalakamperuwa: Goigama.

Radau, Radaw: Washers for superior castes and for Karawe, Chandos, Tailors, Potters, and Barbers, sing. Radawa.

Radayo: Skinners.

Radeas, Raduda: Washermen.

Ragia: Kingly caste, Raja wansaya.

Rajakayo: Removers of dust; Radaw.

Ranhallo: Silversmiths and blacksmiths; brassfounders; Achari.

Rat Karayo: Carriage-makers; Durawo.

Rateetto: Field-cultivators; Goigama.

Ratneenderecarao: Jewelers; Achari.

Rattakarayo: Carriage-makers and manufacturers of harness for chariots or carriages; Sanmahanno.

Real Chitty: Wysya or Vaishya (Merchant) Caste.

Rice-village people: Batgamma Etto or Paduwo.

Ridiceto Ancarao: Inlayers of gold and silver; Achari.

Rodawa: Radawa or Washers.

Rodi: Rhodias, Barbarians or Outcastes, sing. Rodiya.

Rogadikayo: Incurably sick men or lepers; Rodias.

Rope-makers: Ackeranno: Chando.

Roriz: Rodias.

Ruddaugh: Radaw or Washers.

Safframadoo Appuhamy: Hereditary titled persons; Goigama.

Sakani kayo: Bird-killers.

Sakuro: Stonemakers. So called because they make hard cakes of sugar; Jaggery-makers.

Salagama or Salagamayo: People who inhabit the village of large halls. The old name of Chilaw was Salawa. The King of Dambadema of the Seven Corles caused a colony of weavers to be brought from India to Chilaw where spacious halls or apartments were reserved for their use. Chalias.

Samwaduwo: Skin-carpenters; Shoemakers.

Sandal-makers: Sommaru; Karawe.

Sanduruwo or Handuruwo: Sons of peace, the pacific; Goigama.

Sangarammu: Defenders of the priesthood's gardens; Cohabitors with own blood or with sisters; Jaggery-makers.

Sanmahanno: Shoemakers or leather-workers.

Sannawliyo: Cloth-armorers; Mananno or Tailors.

Scavengers: Gahalayo or Candalayo; Paduwo

Sculptors: Galwaduwo.

Seeders: Batgamwella Etto; Goigama.

Seppidiwijji Karayo: Wizards.

Shandos, Shenders: Chandos.

Shepherds: Nillemakareyea or Pattea; Goigama.

Shoemakers: Sommaru.

Shooters: Veddas.

Silversmiths: Baddallo; Smiths.

Sinnawo: Cutters. So called because they cut and bring home materials; Basket-makers.

Sittaru or Sittereo: Painters; Achari.

Skate-fishers: Moru-karawo.

Skin-dressers: Chammakarayo or Hommaru.

Slaves: Wallu (Tamil).

Smiths: Achari, Ranhallo, Nawandanna.

Snaihayo: Hainayo; Radaw or Washers.

Sockikayo: Needleworkers; Tailors.

Solil Karayo: Particular services; Durawo.

Sommarayo: Leather-workmen; Sanmahanno.

Sommaru: Sandal-makers; Karawe.

Soudikayo: Producers of lust. Named after Soudamakaya who first discovered toddy. Chandos.

Sourave: Toddy-drawers.

Stone cutters: Galwaduwo.

SUNNO: Chunam or Lime burners.
SURAWBEEJAYO, SURAWO: Producers of good taste (for bakers); Chando or Toddy-drawers.
SUWANNAKARAYO: Workers in gold; Nawandanno.

TABLINJENOS: Berrawayo or Tomtom-beaters.
TACHAKAYO: Smoothers or planers; Waduwo.
TAILORS: Mananno, Hannali.
TANTAVAYO: Yarn-stretching weavers. So called because they stretched and ordered their warp and wove it with a weft. Chalias.
TARAHALLU: Smiths, sing. Tarahala.
TARUMPAR: Washers of clothes for outcastes.
TATAR: Slaves, itinerant beggars.
TCHOUDERES: Sudras.
TIMBILLO or TIBIBLO: Tamil Fishers.
TINAKARAYO: Workers in grass; Kinnaru.
TOCK-KEULO, TOK KEWULU: Fresh-water Fishers with a peculiar sort of net. Karawe. Tok Fishers.
TODDY-DRAWERS: Chando, Durawo.
TOMTOM-BEATERS: Berawaya or Weavers.
TORTOISE FISHERS: Kespe-karawo.
TRAP-MAKERS: Ugulwadi; Karawe.
TREE-FELLERS, TIMBER-FELLERS: Heeri, Hunu kattanno or Chunna-karayo, Porawa Karayo
TUNNAWAYO: Weavers or sewers of pieces; Mananno or Tailors.
TURNERS: Liane Waduwo.

UGULWADI: Trap-makers for animals; Karawe.
UHULIYO: Oliyas or Dancers.
USANNO: Chandos.

VELENDES or VELENDE VANSE: Merchant caste.
VEDDAS: Hunters. The pre-Sinhalese aborigines of Ceylon.
VELLALA or WELLALE: Goigama.
VELLEDURAI or WELLEDURAI, VELLEDURAYI: Weavers and descendants of Chalias.
VEL-VADUVO: Rattan-workers, Rod-carpenters. So called because they work with or make articles with rods. Sinnawo or Basket-makers.
VINAKARAYO: Players on the Vina.

WADDEWASSAM KARAYO: Builders of bridges. Goigamas.
WADUWO, WADDUWO: Carpenters and Smiths, Achari.
WADEKAYO: Executioners; Karawe.
WADIGHE VANSE, TEHETIS: Merchants or Velendes.
WAGURIKAYO: Fishers who use nets only. Workers or dealers in the water; Karawe.
WAHUNPURAYO: Cooks for Goigama; Jaggery-makers, sing. Wahunpuraya.
WAJJANKARAYO: Tomtom-beaters, sing. Wajjankaraya.
WALLU: Slaves.
WANACHARAKAYO: Wild men or men of the desert; Veddas.
WANIJA WANSAYA: Merchant caste.
WANNEWEDDA: Hunters or Veddas.
WASALO or WASALAYO: Inferior to all; Rodias.
WASHERS, WASHERMEN: Radaw, Pally, Hinnivo, Gangavo, Hiwattayo, Tarumpar.
WATCHMEN: Gauraykawallu, Kappuwo.
WEAVERS: Chalias, Wiyamao or Karawe.
WEDDO: Tormentors, so called because they live by killing animals. Veddas.
WEDDIWANSE: Veddas.
WEEDY: Chando.
WEENAWO: Elephant-catchers.
WELINDO WELLANDU, WYSYA, WIESSIA WANSE: Merchant caste.
WILLIYA: Bird-snarers; Karawe.
WIRAMESTARAGOLLA: Soothsayers or jugglers; Góigama.
WIYAMOO: Weavers; Karawe.
WIYANNO: Weavers.
WOOD CUTTERS: Hunu kottanno.
WOODMEN: Palleru, Pallaru.
WYSYAS, WYSYAYA: Vaisyas, buyers and sellers.

YAKDESSA: A Berawayo who performs Devil Ceremonies.
YAMANOO, YAMAMMU: Iron-smelters; Paduwo, sing. Yamanna.

APPENDIX III: DATA DERIVED FROM HUE AND CRY REPORTS (JAN. 1905–DEC. 1907)

Data are presented on 1,646 persons charged with crimes in the Ceylon Government Police Records. In each case data include name, caste, crime charged, religion, ethnic group, and occupation. In addition the place of birth, haunts, location of family and of relatives and acquaintances, marital status and children, if any, are generally noted. Physical features are also noticed such as complexion (fair or dark), eyes and their defects, hair, nose, age, height, body build, teeth, presence or absence of beard or mustache, and deformities or peculiarities. In the present study data on occupation, crimes charged, religion, and relative numbers in relation to the different castes are summarized.

APPENDIX IV: SINHALESE CASTE NAMES

From Glossary of Native and Foreign Words occurring in Official Correspondence and other Documents. Colombo, 1893.

Āchāri: Blacksmiths
Badahẹlayō: Potters
Baḍallu: Goldsmiths and Silversmiths
Baddeminihā: Tomtom-beater (respectful)
Batgamayō: Paduwō
Berawāyō: Tomtom-beater
Chanḍāla: An outcaste
Durāwe: Chandus, Toddy-drawers
Demaḷa Gattaru (from Demaḷa, Tamil and gattaru, captives)
Embẹṭṭayō: Barbers
Gāḍi: Roḍiyā (respectful)
Gahalayo, Gahalagambaḍayo: Executioners, Scavengers
Gal-addo: Lapidaries, workers in precious stones
Gasmandā: A Roḍiyā
Gattaru: A low caste
Goyigama: Vellālas, Cultivators
Gurunnehe: Tomtom-beater (respectful)
Guruwo: Sinhalese caste mixed with Moors
Hakurō: Jaggery-makers
Halāgama: Corruptly Chālias, Cinnamon-peelers
Hāli: Chālias
Handuruwō: Vellālas
Haṅgarammu: Wahunpurayō (respectful)
Hannāli: Tailors
Hēnayā: A washer
Hinnāwō: Washers for Chālias
Hunnō: Lime-burners
Karāwō: Fishers
Kinnaru: Mat-weavers
Kumballu: Potters
Kurundukārayō: Cinnamon-peelers
Lōkuruwō: Brass-founders
Maḍamēminihā: Guruwo (respectful)
Mahabaddē: Halāgama or Chālias
Nẹkatiyā: Tomtom-beater; astrologer
Olī: Dancers
Paduwō: Palanquin-bearers
Palī: Washers for low castes
Pallaru: Subdivision of Palī
Pannayō: Grass-cutters
Radaw: Washers
Raṭēminihā: A Vellāla
Roḍiyā: An Outcaste
Salāgama: Chālias
Wahunpurayō: A Cook or Jaggery-maker
Yamānna, Yapammu: Smelters of Iron

APPENDIX V: ILLUSTRATIONS OF SINHALESE CASTES IN THE LITERATURE

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- *Potter*, facing p. 46.
- *Kandyan dancers*, facing p. 71.

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- *Barber*, facing p. 85.
- *Cinnamon-peeler*, facing p. 141.
- *Toddy-drawer*, facing p. 181.
- *Potter*, facing p. 202.
- *Rodiya* at Udugalpitiya, facing p. 245.
- *Silversmith*, facing p. 315.
- *Devil dancers*, facing p. 389.

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- *Mat-weaver* (*Kinnarayo*), pl. 4, fig. 1.
- *Potters*, pl. 5, figs. 1–4.
- *Horn-combmaker* (*Rodiya*), pl. 5, fig. 9.
- *Cloth-weavers* (*Berawayo*), pl. 6, figs. 1–3.

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BOTANY.—*Seven new species of Gesneriaceae from Peru and Colombia.*[1] C. V. MORTON, U. S. National Museum.

The seven new species of Gesneriaceae here described have been detected in recent collections from Colombia and Peru. One of them was found by Prof. César Vargas, of the University of Cuzco, and another by Dr. W. A. Archer, of the U. S. Department of Agriculture. The remaining ones were all collected in the Department of Antioquia, Colombia, by Dr. R. D. Metcalf and Dr. José Cuatrecasas, as members of the third University of California Botanical Garden Expedition to the Andes. For the privilege of studying the latter I am indebted to Prof. T. H. Goodspeed, of the University of California. The proposed new species belong to the genera *Besleria*, *Centrosolenia*, *Columnea*, and *Episcia*.

Besleria Vargasii Morton, sp. nov.

Frutex, caulibus subquadrangularibus, strigosis; petioli elongati; lamina foliorum ovalis, basi rotundata, denticulata, supra strigosa, mox glabrescens, subtus praecipue in venis strigosa, venis primariis 14- vel 15-jugis; inflorescentia cymosa, longe pedunculata, floribus numerosis; calycis lobi fere liberi, suborbiculares, rotundati, sub apice mucronati, venosi, externe paullo strigosi, perspicue ciliato-fimbriati; corolla aurantiaca, erecta, basi non gibbosa, externe pilosula, intus basi glabra, faucem versus glandulosa, limbo terminali, subregulari; filamenta corollae tubi basin versus affixa, glabra; antherae parce glandulosae; ovarium glabrum; stylus glaber; stigma bilobum; discus semiannularis.

Shrub 3 meters high; stems subquadrangular, 4–5 mm in diameter, densely and coarsely sericeous-strigose above, glabrescent below; leaves opposite, equal, long-petiolate, the petioles about 7 cm long, densely sericeous, the blades oval, 15–19 cm long, 8–11 cm broad, short-acuminate at apex, rounded and subcomplicate at base, papyraceous, remotely denticulate, deep green above, paler beneath, sericeous-strigose above when young, soon glabrate, persistently strigose beneath on the veins, the primary veins 14 or 15 pairs, elevated beneath; inflorescence axillary, solitary, corymbose, many-flowered, long-pedunculate, the peduncles 12–16 cm long, sericeous-strigose, the pedicels 7–10 mm long in flower, up to 2.2 cm long in fruit, strigose, slightly thickened at apex; calyx 3–4 mm long in flower, the lobes nearly free, equal, orbicular or broader than long, rounded at apex, conspicuously venose, lacking a midrib, slightly mucronate below apex, suberose, thinly sericeous externally, glabrous within, conspicuously and coarsely ciliate-fimbriate; corolla orange, 13–15 mm long, erect in calyx, not spurred or gibbous at base, the tube cylindric, 4–5 mm broad, slightly ventricose toward apex, becoming 5.5–6 mm broad, slightly contracted in throat, sparingly pilosulous externally, lacking a hairy ring within at insertion of filaments, glandular-pilosulous within throat, the limb terminal, subregular, 5–6 mm broad, the lobes suborbicular or broader than long, spreading or reflexed, rounded, glabrous and eglandular on both sides, not ciliate; filaments broad, flattened, inserted about 2 mm above base of corolla tube, glabrous, eglandular; anthers connivent, about 1 mm long, 2 mm broad, the cells orbicular, confluent at apex, sparingly glandular; ovary glabrous; style glabrous; stigma bilobed, pubescent; disk semiannular, glabrous; berries (immature) spherical, 7 mm in diameter.

Type in the U. S. National Herbarium, no. 1875008, collected at Mandor, Marcapata, Province of Quispicanchis, Department of Cuzco, Peru, at an elevation of 1,200 meters, December 11, 1943, by C. Vargas (no. 3732).

The most nearly allied species is *Besleria tetrangularis* Ruiz, also a native of Peru, which differs in the much shorter hairs of the stems, shorter petioles, smaller leaf blades with fewer lateral veins, much broader corollas, and filaments inserted in the middle of the corolla tube rather than near the base.

Centrosolenia conferta Morton, sp. nov.

Caules radicantes, ramulis brevissimis; folia rosulata, cujusque paris valde inaequalia, majora anguste elliptica, infra medium usque ad basim gradatim attenuata, apice acuminata,

[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 16, 1945.

serrulata, supra viridia, glabra, subtus pallidiora, in venis strigillosa, venis primariis 10-vel 11-jugis; folia minora stipuliformia, subulata, angustissima; flores axillares, conferti, pedunculo communi obsoleto, pedicellis sparse albo-pilosis; bracteae rubrae, inconspicuae, angustae; calycis lobi rubri, lineari-subulati, posticus deflexus, brevior, remote glanduloso-denticulati, utrinque strigillosi; corolla alba, apice rubro-maculata, calcarata, tubo angusto, sursum ventricoso, externe pilosulo, limbo amplo, patente; filamenta glabra; antherae glabrae, basi subsagittatae; ovarium villosum; stylus pilosulus; stigma pubescens; discus in glandulam elongatam solitariam reductus.

Stem about 6 mm in diameter, radicant, giving rise to short branchlets barely 1 cm long, these strigillose, bearing a few leaves in a rosette; leaves of a pair strongly unequal, the larger 20–32 cm long, the expanded part 15–20 cm long, 4.2–5.8 cm broad, gradually narrowed below middle to a petiole-like base 4–12 cm long (a proper petiole lacking or nearly so), thin-chartaceous, remotely biserrulate, acuminate at apex, green and glabrous above, paler beneath, strigillose on the midrib and veins, the primary veins 10 or 11 pairs; smaller leaf of a pair stipule-like, nearly filiform, about 1.8 cm long, less than 1 mm broad; flowers axillary, crowded, the common peduncle obsolete, the pedicels 10 mm long, sparingly white-pilose; bracts inconspicuous, about 14 mm long and 1 mm broad, entire, pilose; calyx lobes red, free, linear-subulate, subequal, 18–19 mm long (the posterior deflexed at base, about 16 mm long), 1.5–2 mm broad, filiform-attenuate, slightly narrowed toward base, remotely glandular-denticulate (the teeth 1–3 to a side), sparsely strigose on both sides; corolla white with a broad red stripe on anterior side below apex, about 35 mm long, oblique in calyx, calcarate at posterior base, the tube very slender near base, about 1.5 mm broad, rather abruptly enlarged and ventricose upwardly, becoming 7 mm broad, contracted to throat (this 6 mm broad), finely pilosulous externally, glabrous within, the limb ample, spreading, 18 mm broad, the lobes rotund, not fimbriate, glandular within; filaments glabrous; anthers connivent but not connate, about 2 mm long, 1.6 mm broad, subsagittate at base, glabrous, the cells oblong, discrete, parallel, the connective not thickened; ovary elongate, densely villous; style conspicuously pilosulous; stigma bilobed, pubescent; disk reduced to a solitary, elongate, acute, glabrous, posterior gland.

Type in the U. S. National Herbarium, no. 1833447, collected north of Dabeiba, on road to Turbo, Department of Antioquia, Colombia, at an elevation of 300 to 350 meters, February 25 to March 1, 1942, by R. D. Metcalf and J. Cuatrecasas (no. 30200).

Related to *Centrosolenia decurrens* Morton of Costa Rica, which may be distinguished as follows:

Anthers bearded at apex; calyx lobes entire; hairs of stems and pedicels red; leaf blades hirsute along midrib beneath . . . . **C. decurrens**

Anthers glabrous; calyx lobes remotely glandular-denticulate; hairs of stems and pedicels white; leaf blades strigillose beneath on midrib. **C. conferta**

Columnea parviflora Morton, sp. nov.

Caules vix ramosi, apice rubro-hirsuti; folia cujusque paris valde inaequalia, breviter petiolata; lamina foliorum majorum elliptica, acuta, basi obliqua, serrulata, supra viridis, albo-hirsuta, subtus ubique rubro-purpurea, hirsuta, venis primariis 4-jugis; folia minora stipuliformia, lineari-lanceolata; flores in axillis aggregati, breviter pedicellati; calycis lobi liberi, valde inaequales, 2 antici suborbiculares, denticulati, obtusi, unguiculati, 2 laterales obovato-spathulati, unguiculati, denticulati, posticus parvus, lineari-lanceolatus, attenuatus, integer, omnes rubri, dense utrinque hirsuti (posticus intus glaber); corolla minuta, erecta, dense albo-sericeo-pilosa, limbo regulari, lobis minutis, erectis; antherae parvae, liberae; ovarium albo-pilosum; discus in glandulam posticam reductus.

Stems unbranched, or branched at base only, 30–35 cm long, 2.5–3 mm in diameter, densely red-hirsute in younger parts; leaves of a pair strongly unequal, the larger short-petiolate, the petiole 4–7 mm long, hirsute; larger leaf blades elliptic, 4.5–9.5 cm long, 2–5.5 cm broad, acute, oblique at base, the lower base rounded or subcordate, the upper cuneate, serrulate, chartaceous, fragile when dry, green and white-hirsute above, red-purple all over beneath, white-hirsute, especially along the midrib, the primary veins 4 pairs; smaller leaves of a pair petiolate, the blades linear-lanceolate, not over 1 cm long and 2 mm broad,

acuminate, entire or toothed, green and nearly glabrous above, red beneath; flowers 2–5 in an axil, short-pedicellate, the pedicel 2–8 mm long, bracteate at base, the bracts minute, lanceolate, 2–7 mm long, acuminate, red; calyx lobes free, very unequal, the posterior one erect, linear-lanceolate, 5–7 mm long, 0.8–1.5 mm broad, attenuate, entire, the two lateral spatulate-obovate, 7–8 mm long, 4.5–6 mm broad above middle, concave, subrecurved, unguiculate, glandular-denticulate upwardly (the teeth 1 or 2 to a side), acute at apex, the two anterior lobes suborbicular, 8–9 mm long, 7–9 mm broad, concave, subrecurved, unguiculate, obtuse at apex, glandular-denticulate (the teeth 2 or 3 to a side), all lobes red, densely red-hirsute on both sides (except the posterior, this glabrous within), accrescent after anthesis; corolla yellow, 7–8 mm long, erect in calyx, gibbous at posterior base, the tube cylindric, not ventricose, straight, 2 mm broad at base, 2.5 mm broad above base, densely white-sericeous-pilose externally, glabrous within, the throat 1.5 mm. broad, the limb subregular, about 3 mm broad, the lobes minute, erect, about 1 mm long, long-pilose without, glabrous within; filaments very slender, glabrous, the sheath elongate; anthers free, oblong, minute, 0.5–0.6 mm long, 0.3–0.4 mm broad; ovary white-pilose; style glabrous, slender; stigma conspicuously bilobed; disk reduced to a single entire or bilobed, posterior gland.

Type in the U. S. National Herbarium, no. 1517373, collected at Tutunendo, 20 kilometers north of Quibdó, Intendencia del Chocó, Colombia, at about 80 meters elevation, May 19–20, 1931, by W. A. Archer (no. 2145).

Additional specimens examined:

Colombia. El Chocó: La Concepción, 15 km east of Quibdó, alt. 75 meters, *Archer* 2076, 2205. El Valle: Near highway bridge over Río Dagua, about 20 km east of Buenaventura, alt. 40 meters, *Killip & García* 33331. Antioquia: North of Dabeiba, along road to Turbo, alt. 300–350 meters, *Metcalf & Cuatrecasas* 30179.

This plant is evidently an epiphyte and is so described on all the specimens cited above except the type. Archer's note on his no. 2145 says "on the ground," but this is probably an error. The specimen has the appearance of an epiphyte. According to Archer's notes, the fruit is white.

Columnea parviflora has the smallest corolla of any described *Columnea*. It is doubtful to which section it should be referred, but the closest relationship seems to be with *Columnea Lehmannii* Mansf. and *C. Herthae* Mansf., both of which Mansfeld referred with doubt to sect. *Collandra*. *Columnea parviflora* may be distinguished from these as follows:

Ovary glabrous. Corolla 18 mm. long . . **C. Herthae**
Ovary sericeous-pilose.
  Corolla 26 mm. long, the lobes about 4 mm. long; leaf blades acuminate . . **C. Lehmannii**
  Corolla 7–8 mm. long, the lobes about 1 mm. long; leaf blades acute . . . . **C. parviflora**

Columnea Lehmannii was described from a specimen collected on the western slopes of the Western Andes of Popayán, El Cauca, Colombia, at a comparatively high altitude (1,200–1,500 meters). The type is *Lehmann* 6063. I have not seen it, but the following collection agrees very well with the description: West of Río San Joaquin, Micay Valley, El Cauca, alt. 1,200–1,400 meters, *Killip* 7884.

Columnea Herthae was described from San Carlos de los Colorados, Ecuador (*Schulze-Rhonhof* 1939). I have seen no specimens answering the description.

Columnea pulcherrima Morton, **sp. nov.**

Caules elongati, non ramosi, dense rubro-hirsuti; folia cujusque paris valde inaequalia, sessilia; lamina foliorum majorum oblanceolata, abrupte et argute acuminata, basi valde inaequalis, cordata, serrulata, supra viridis, hirsuta, subtus viridis, marginibus et venis perspicue rubro-purpureis exceptis, hirsuta, venis primariis 7- vel 8-jugis; flores axillares, conferti, longe pedicellati; bracteae rubrae, inconspicuae, lineari-lanceolatae, integri; calycis lobi liberi, lineari-subulati, subulato-dentati, dentibus 5- vel 6-jugis, elongatis, perspicue longe hirsuti, intus glabri; corolla lutea, faucem versus rubra, basi gibbosa, tubo cylindrico, piloso, limbo subregulari, lobis non ciliatis; filamenta glabra; antherae exsertae, connatae, quadratae; ovarium parce pilosum; stylus glaber; discus in glandulam magnam posticam et glandulam anticam parvam reductus.

Stems climbing, unbranched, 70 cm long or more, becoming 1 cm in diameter, about 5 mm in diameter near apex, densely red-hirsute, the hairs 3–4 mm long; leaves of a pair strongly unequal, sessile; larger leaf blades oblanceo-

late, 14–24 cm long, 4.5–8 cm broad, abruptly and sharply acuminate at apex, strongly unequal at base, cordate, membranaceous, fragile when dry, inconspicuously serrulate, green above, short-hirsute (the hairs flaccid, white, few-celled), red-purple beneath all around margin and along midrib and usually at apices of the primary veins, elsewhere green, short-hirsute, the primary veins 7 or 8 pairs; flowers axillary, crowded, the pedicels slender, 4–8 in an axil, 3–3.5 cm long, conspicuously long-red-hirsute; bracts red, inconspicuous, linear-lanceolate, about 15 mm long, 2–3.5 mm broad, long-attenuate, entire, hirsute; calyx lobes free, erect, linear-subulate, about 25 mm long (the posterior one about 20 mm long), 2 mm. broad, attenuate to a filiform apex, subulate-toothed (the teeth 5 or 6 to a side, up to 7 mm long and 0.2 mm broad), densely hirsute externally (the hairs red, many-celled, flaccid, 2–5 mm long), glabrous within; corolla yellow with a red band around throat, 4–4.7 mm long, erect in calyx, gibbous at posterior base, narrowed to about 3.5 mm above base, the tube cylindric, 7–10 mm broad at middle, minutely puberulous externally and also sparsely long-pilose (the hairs colorless, eglandular), glabrous within, slightly narrowed to throat, the limb subregular, 7–9 mm broad, the lobes erect, yellow, about 4 mm long, not ciliate; filaments connate at base into a sheath about 6 mm long, glabrous; anthers exserted at maturity, connate, quadrate, 1.5 mm long and broad, the cells discrete, parallel, dehiscent throughout; ovary sparingly pilose; style glabrous; disk composed of one large posterior gland and a smaller anterior gland.

Type in the U. S. National Herbarium, no. 1833423, collected north of Dabeiba, along road to Turbo, Department of Antioquia, Colombia, at 300 to 350 meters elevation, February 25 to March 1, 1942, by R. D. Metcalf and J. Cuatrecasas (no. 30174).

The present species is not closely related to any of the described members of the section *Collandra*, but is very near one as yet undescribed that was collected in the Intendencia of Chocó by E. P. Killip (nos. 35024 and 35051). *Columnea rubrocincta*, described below, has a similar corolla, but is not really of close affinity. The two are different in many ways, some of which may be indicated as follows:

Leaf blades red all over the lower surface, 6–10 cm long, acute; calyx lobes 6.5–7 mm long, bearing 1 pair of teeth; corolla 2.8–3.5 cm long, the lobes ciliate with capitate-glandular hairs; filaments glandular-pilosulous . . **C. rubrocincta**

Leaf blades red on margins and veins only, hirsute, 14–24 cm long, sharply acuminate; calyx lobes 25 mm long, bearing 5 or 6 pairs of teeth; corolla 4–4.7 cm long, the lobes not ciliate; filaments glabrous . . . . **C. pulcherrima**

Columnea rubrocincta Morton, sp. nov.

Planta terrestris, caulibus elongatis, apicem versus foliosis, substrigosis; folia cujusque paris valde inaequalia; lamina foliorum majorum obovato-oblonga, acuta, basi valde inaequalis, rotundata vel truncata, crenata, supra viridis, strigosa, subtus rubro-purpurea ubique, strigosa, venis primariis 6-jugis; folia minora subsessilia, ovata vel elliptica, parva; flores in axillis conferti, pedicellis ca. 6; calycis lobi liberi, erecti, aequales, lanceolati, acuminati, subulato-dentati, utrinque pilosi; corolla lutea, apicem versus rubrocincta, erecta, basi gibbosa, tubo cylindrico, recto, faucem versus paullo constricto, externe puberulo et pilis capitato-glanduliferis dissitis praedito, limbo subregulari, lobis superioribus paullo connatis, rubris, alteris deltoideis, luteis; filamenta glandoloso-pilosula; antherae connatae; ovarium dense pilosum; discus in glandulam posticam reductus.

Terrestrial; stems unbranched, 80 cm long or more, 8–9 mm in diameter, leafy only near apex, substrigose, the hairs white; leaves of a pair strongly unequal, the larger short-petiolate, the petiole 5–10 mm long, appressed-pilose; larger leaf blades obovate-oblong, 6–10 cm long, 3–4.7 cm broad, acute, unequal at base, rounded or truncate on both sides at base, inconspicuously crenate, chartaceous, green above, strigose, red-purple all over beneath, strigose, the primary veins 6 pairs; smaller leaves of a pair subsessile, the blades ovate to elliptic, 1.7–3.2 cm long, 1.1–1.3 cm broad, acute, subcordate at base, green above, red-purple beneath; flowers axillary, the pedicels about 6 in an axil, about 1 cm long, densely white-appressed-pilose; bracts minute, linear, 4–5 mm long, entire; calyx lobes brown, free, erect, equal, lanceolate, 6.5–7 mm long, 2 mm broad (excl. teeth), acuminate, bearing a single pair of subulate teeth below the middle (the teeth about 1.5 mm long, 0.2 mm broad),

densely white-hirsute externally, pilose within; corolla yellow with a conspicuous red band around the throat, 2.8–3.5 cm long, erect in calyx, conspicuously gibbous at posterior base, narrowed above base to 3.5 mm broad, the tube cylindric, 8–9 mm broad at middle, slightly narrowed in throat (this 6–8 mm broad), finely puberulous externally (the hairs mixed with longer, capitate-glandular ones), glabrous within, puberulous within throat, the limb subregular, 6–8 mm broad, the 2 upper lobes about 4 mm long, connate for 1 mm, red, the other 3 lobes yellow, free, deltoid, about 2.5 mm long, 5 mm broad at base, ciliate (the hairs capitate-glandular); filaments connate into a sheath for 5 mm at base, glandular-pilosulous above; anthers exserted, persistently connate, broader than long, about 1.6 mm long, 2 mm broad, the cells discrete, parallel, dehiscent throughout; ovary densely white-pilose; style glabrous; stigma slightly bilobed; disk reduced to a thick, posterior gland.

Type in the U. S. National Herbarium, no. 1850674, collected between Valdivia and Yarumal, Department of Antioquia, Colombia, at 2,200 meters elevation, February 20, 1942, by R. D. Metcalf and J. Cuatrecasas (no. 30133).

Columnea rubrocincta belongs to section *Collandra.* Only two or three species of this section have been described from Colombia, but a dozen or more are represented in recent collections. Among the features of the present species to be especially noted are the uniformly red-purple lower surfaces of the leaves, pubescence of a strigose type, the relatively small calyx lobes, each with a single subulate tooth, the yellow corolla much exceeding the calyx and bearing a conspicuous red band at the throat, the capitate glands on corolla and filaments, and the exserted anthers.

Columnea silvatica Morton, sp. nov.

Epiphytica; caules parce strigillosi; folia cujusque paris aequalia, breviter petiolata; lamina oblongo-lanceolata, acuminata, basi cuneata, integra, revoluta, supra glabra, subtus parce strigillosa, venis primariis 2-jugis; flores solitarii, breviter pedicellati; calycis lobi liberi, aequales, ovato-lanceolati, longe attenuati, basi perspicue dentati, externe pilosi, intus glabri; corolla coccinea, erecta, non calcarata, tubo calycem multo superante, valde bilabiata, galea acuta, lobis lateralibus brevibus, acutis; ovarium apice sparse pilosum; discus in glandulam posticam bilobam reductus.

Epiphyte; stems about 40 cm long, sparingly branched, about 3 mm in diameter, sparsely strigillose; leaves of a pair equal, short-petiolate, the petiole 3–4 mm long, sericeous-pilose; leaf blades narrowly oblong-lanceolate, 4.5–7 cm long, 9–11 mm broad, long-acuminate, cuneate at base, chartaceous and fragile when dry, entire, somewhat revolute, pale and glabrous on upper surface, darker beneath, sparsely strigillose, the lateral veins 2 pairs, obscure above, the secondary veins obscure on both sides; flowers solitary, axillary, ebracteate, the pedicel 7–10 mm long, erect, red-sericeous-pilose; calyx lobes red, free, erect, equal, ovate-lanceolate, about 2 cm long, 12 mm. broad near base (including teeth), sharply long-attenuate at apex (the apex itself entire, 15 mm long, 5 mm broad at base), deeply toothed at base (the teeth 5 or 6 to a side, the largest 5 mm long and 1.6 mm broad at base), sericeous-pilose externally, especially at base of midrib, glabrous within, ciliate; corolla scarlet, erect in calyx, not calcarate at base, about 5 cm long, the tube about 3.5 cm long, about 3 mm broad at base, straight, gradually enlarged upwardly, about 7 mm broad at throat, sparsely jointed-pilose externally, the limb strongly bilabiate, the galea about 1.6 cm long, the free part 9 mm long, 7.5 mm broad, acute, the lateral lobes short, the free parts 4 mm long and 2.5 mm broad at base, acute, the lower lobe 10 mm long, 3 mm broad; anthers oblong, 1.3 mm long, 0.8 mm broad, the cells discrete, parallel, longitudinally dehiscent; ovary sparsely long-pilose at apex; disk reduced to a bilobed, glabrous, posterior gland.

Type in the U. S. National Herbarium, no. 1833439, collected north of Dabeiba, along road to Turbo, Department of Antioquia, Colombia, at an elevation of 300 to 350 meters, February 25 to March 1, 1942, by R. D. Metcalf and J. Cuatrecasas (no. 30191). A second specimen was collected at the same locality, *Metcalf & Cuatrecasas* 30178. The collectors state that the plant grows in deep rain-forest (rainfall 320 inches a year) in the crotches of trees, always at least 10 feet from ground. The leaves are succulent when fresh.

Species of the section *Eucolumnea* are not numerous in Colombia, the center of development being in Costa Rica. The present species is perhaps related to *C. Kienastiana* Regel,[2] described from "Colombian Andes" from a collection of R. Pfau, from which it may be separated as follows (from description):

Leaves (incl. petiole) 2.5–3.5 cm long, subrotund at base; calyx lobes 11–12 mm long, $\frac{1}{6}$ as long as corolla, bearing 1 or 2 teeth at base; corolla tube about equalling limb . . . . . **C. Kienastiana**
Leaves (incl. petiole) 4.8–7.4 cm long, cuneate at base; calyx lobes 20 mm long, more than $\frac{1}{3}$ as long as corolla, bearing 5 or 6 teeth at base; corolla tube much longer than limb. **C. silvatica**

Regel described[3] another species from Colombia, *C. ringens*, also from a collection of R. Pfau. This also is known to me from description only. It is evidently more distantly related and may be distinguished as follows:

Corolla 3 cm long, the tube shorter than the calyx lobes; calyx lobes denticulate or subentire; leaf blades up to 27 mm broad . . . . **C. ringens**
Corolla 5 cm long, the tube much exceeding the calyx lobes; calyx lobes conspicuously and deeply toothed; leaf blades 9–11 mm broad. **C. silvatica**

Episcia peltata Morton, sp. nov.

Herba decumbens, caulibus basi radicantibus, sursum parce hirsutis; folia cujusque paris aequalia, longe petiolata, petiolo rubro, hirsuto; lamina foliorum elliptico-oblonga, magna, acuta, prope basin perspicue peltata, herbacea, grosse dentata, supra pilosa, subtus hirsuta, venis rubris, primariis 10–13-jugis; flores axillares, conferti, pedunculo communi brevissimo, pedicellis elongatis, hirsutis; bracteae lineares; calycis lobi liberi, lineari-oblongi, obtusi, basi angustati, glanduloso-denticulati, externe pilosi, intus glabri; corolla flava, obliqua, subcalcarata, tubo cylindrico, tenuiter piloso, limbo magno, patente, lobis non ciliatis; filamenta glabra; antherae oblongae, glabrae; ovarium pilosum; stylus glaber; stigma bilobum; discus in glandulam angustam posticam reductus; lamellae placentarum intus solum ovuliferae.

Decumbent herb 30–50 cm long, the stems red, 4–5 mm in diameter, radicant at the lower nodes, sparingly hirsute upwardly; leaves of a pair equal, long-petiolate, the petiole 6–10 cm long, red, hirsute, enlarged and flat at base; leaf blades elliptic-oblong, the well-developed ones 11.5–22 cm long, 4–8 cm broad, acute, peltate, the petiole inserted 3–7 mm above base, the leaf base itself rounded, herbaceous, deeply dentate or doubly dentate to base, sparsely pilose above, hirsute beneath, green on both sides, the midrib and veins red beneath, the primary veins 10–13 pairs; inflorescence axillary, the flowers numerous, crowded, borne on a short common peduncle (1–2 mm long), the pedicels elongate, 2–2.4 cm long, reddish, hirsute; bracts inconspicuous, linear, up to 1.8 cm long and 2.5 mm broad, attenuate to both ends, entire, sparsely pilose; calyx lobes free, linear-oblong, about 14 mm long, 3 mm broad (the posterior one narrower, 2.5 mm broad), obtuse, slightly narrowed toward base, glandular-denticulate (the teeth 1 or 2 to a side), sparsely jointed-pilose externally, glabrous within; corolla yellow, oblique in calyx, about 35 mm long, subcalcarate at posterior base, the tube cylindric, 3–4 mm broad at middle, about 25 mm long, finely pilose externally, glabrous within, slightly enlarged to throat, glandular within throat, the limb ample, widely spreading, 20–25 mm broad, bilabiate, the lobes entire, not ciliate, the anterior and posterior large, the lateral smaller; filaments slender, glabrous; anthers free, barely exserted from corolla tube, glabrous, 1 mm long, 0.8 mm broad, the cells oblong, discrete, parallel, dehiscent throughout, the connective not enlarged or extended; ovary densely pilose; style glabrous; stigma conspicuously bilobed; disk reduced to a narrow, elongate, acute, glabrous, posterior gland; ovules borne only on the inner surface of placentae.

Type in the U. S. National Herbarium, no. 1833352, collected on banks of Río Cauca at Puerto Valdivia, Department of Antioquia, Colombia, at 240 to 260 meters elevation, February 17 to 20, 1942, by R. D. Metcalf and J. Cuatrecasas (no. 30098).

Pending a revision of the group, the genus *Episcia* is here accepted in the inclusive sense of Bentham and Hooker. The present species does not belong in *Episcia* in the restricted sense as emended by Sprague. It differs from all described species of *Episcia* in its peltate leaves.

[2] Act. Hort. Petrop. 8: 274. 1883.
[3] Op. cit. 273.

ICHTHYOLOGY.—Emmelichthyops atlanticus, *a new genus and species of fish (family Emmelichthyidae) from the Bahamas, with a key to related genera.*[1]
LEONARD P. SCHULTZ, U. S. National Museum.

While looking through Dr. A. E. Parr's publication "Teleostean Shore and Shallow-water Fishes from the Bahamas and Turks Island" (Bull. Bingham Oceanogr. Coll. 3 (4): 60. 1930), I observed that figure 12 did not agree with Poey's figure of his species *Inermia vittata* from Cuba. Poey's specimens in the national collections confirmed this observation, and upon writing to Dr. Daniel Merriman, director of the Bingham Oceanographic Laboratory, the two specimens on which Parr's figure was based were kindly lent to me for study and description. I am most grateful to Dr. Merriman for the loan of the specimens and for permission to describe them in this paper.

Family EMMELICHTHYIDAE

Before it was possible for me to assign this new genus and new species to any family of fishes, its relationships were compared with several forms that appear related to it. Various authors have placed these genera in the following families: Emmelichthyidae, Centracantidae, Maenidae, Merolepidae, Erythrichthyidae, Dipterygonotidae, and Inermiidae, all of which I propose to unite in the single family Emmelichthyidae, which is defined as follows:

Marine fishes with the body oblong, fusiform, or compressed; mouth oblique, the lower jaw longer than or equal to upper jaw; teeth obsolete, small, or well developed on jaws or vomer, usually lacking on palatines and pterygoids; preopercle entire, with thin membranous posterior border, with or without thin serrae or small spines at least in the young; opercle with or without one or two flat thin spines; premaxillaries greatly protractile, the ascending bony process reaching to orbits or even to rear of orbits, nearly to occiput; gill membranes free from isthmus, extending far forward, with a narrow free fold across isthmus; gills 4, with a slit behind fourth arch; pseudobranchiae present; lower pharnygeals with teeth; pyloric caeca few; nostrils paired; scales strongly ctenoid, covering body and head, except snout, lower jaw and sometimes underside of head; a scaly sheath along soft rayed parts of both dorsal and anal fins but no scales on these fins; caudal fin scaled, deeply forked or emarginate; lateral line continuous, complete, ending on caudal fin, mostly following dorsal contour anteriorly but running along middle of side of caudal peduncle; accessory pelvic scale well developed; pelvics I, 5, thoracic, inserted nearly under base of pectorals, the latter usually with scaly bases; spiny dorsal and soft dorsal continuous or separated, with VIII to XVII spines and 9 to 25 soft rays; anal fin with II or III spines and 8 to 24 rays; all fin spines slender; gill rakers slender, numerous; air bladder present; the maxillary either slips under the preorbital or is almost fully exposed posteriorly; the dentary has a large dorsally projecting leaf-like bony lobe posteriorly inside of mouth.

Several genera in this group of fishes have been reviewed in part by other ichthyologists, and the literature has been brought together by them, and so it is not necessary for me to give a complete bibliography.

Dr. Paul Chabanaud published in 1924 a small paper entitled "Remarques sur *Dipterygonotus gruveli* Chab. et sur la Famille des Dipterygonotidae" (Bull. Soc. Zool. France **49**: 248–256) in which he gives a synoptic key to the genera *Inermia, Plagiogeneion, Erythrodes, Boxaodon, Emmelichthys,* and *Dipterygonotus.* There follows a section listing the various species under each genus. The next review or analysis of genera was given by Henry W. Fowler (U. S. Nat. Mus. Bull. 100, **12**: 344. 1933) under the family name Emmelichthyidae, in which the following genera were recognized: *Emmelichthys, Dipterygonotus, Inermia, Erythrodes, Plagiogeneion,* and *Cypselichthys.* A list of species for each genus is given with synonymy. In 1936 three genera belonging in this group of fishes were placed in the family

[1] Published by permission of the Secretary of the Smithsonian Institution. Received February 21, 1945.

Centracantidae by Fowler in his big work entitled "The Marine Fishes of West Africa" (Bull. Amer. Mus. Nat. Hist. **70** (2): 860–865, 1300–1301).

From my examination of the literature it appears that this is the first time the Maenidae have been combined with the Emmelichthyidae into a single family. This seems a logical step, however, when based on the external anatomy and such bony structures as can be examined without the preparation of formal skeletons. The true relationships within the present family, and perhaps other genera not yet referred to this group, will have to be worked out from carefully prepared skeletons when material for the genera, now apparently lacking, becomes available in the museums where such a study could be made. My arrangement, therefore, is a tentative one, and I am unable to conclude of what significance the maxillary may be in slipping almost completely under the preorbital in one group of genera while in the other group the maxillary is almost wholly exposed posteriorly. Otherwise these genera appear to have much in common.

Emmelichthyops, n. gen.

Genotype.—*Emmelichthyops atlanticus*, n. sp.

This new genus is essentially characterized by the two dorsal fins completely separated, the space between fully scaled, the first dorsal spiny, the second with a feeble spine followed by soft rays; the pelvics are thoracic, inserted a trifle behind a vertical line through rear of pectoral bases; body fusiform, snout bluntly pointed; caudal peduncle rounded, rather slender; caudal fin deeply forked, lobes pointed; the maxillary slips under preorbital and is mostly concealed by it; eye large; scales ctenoid, on body and head, except snout, and underside of head; gill membranes extending far forward, free from isthmus; gill rakers slender, numerous; teeth minute on jaws, none on vomer, palatines, pterygoids, or tongue; premaxillaries excessively protractile, the ascending process extending a trifle past a line through rear of orbits. Other characters are those of the genotype described on the following pages.

It differs from all other genera referred to the family Emmelichthyidae in having the first or spiny dorsal completely separated from the second dorsal fin. It may be separated from other related genera by the accompanying key.

Named *Emmelichthyops*, meaning appearing like *Emmelichthys*.

Emmelichthyops atlanticus, n. sp.

Emmelichthys vittatus (non Poey) Parr, Bull. Bingham Oceanogr. Coll. **3** (4): 60, fig. 12. 1927 (the two specimens herein described).

Holotype.—B.O.C. 2515, a specimen, 98 mm. in standard length, from Cat Island, Bahamas, taken at night with surface light, *Pawnee*, March 21–22, 1927.

Paratype.—U.S.N.M. 123165, a specimen 80 mm. long, bearing same data as holotype.

The following measurements, expressed in hundredths of the standard length, are recorded first for the holotype, then for the paratype. Standard lengths 98 and 80 mm. Total lengths 116 and 94 mm.

Greatest depth of body at front of spiny dorsal fin 17.4 and 19.0; length of head 24.6 and 27.7; length of snout 7.96 and 8.75; diameter of orbit 7.66 and 9.12; postorbital length of head 10.8 and 11.9; least width of bony interorbital space 6.02 and 6.50; tip of snout to rear edge of maxillary 9.90 and 11.0; edge of anterior nostril to tip of snout 4.49 and 5.25; edge of posterior nostril to eye 2.35 and 2.38; distance from base of last anal ray to midbase of caudal fin 21.4 and 21.3; least depth of caudal peduncle 5.82 and 6.62; pelvic insertion to anal origin 35.7 and 32.6; anus (center) to anal origin 6.94 and 7.12; tip of snout to origin of spiny dorsal fin 35.2 and 37.5; to second dorsal 66.2 and 68.0; to anal origin 65.8 and 65.0; tip of snout to pectoral insertion 25.5 and 28.0; to pelvic insertion 30.1 and 32.4; tip of snout to center of anus 58.7 and 57.9; length of longest (third or fourth) dorsal spine 14.3 and 15.4; longest anal spine (second) 4.59 and 2.75; length of spine at front of second dorsal 2.35 and 2.87; length of pelvic spine 8.37 and 10.0; longest soft ray of dorsal fin 9.08 and 10.9, anal fin 8.67 and 9.75, pectoral 14.3 and 15.0, pelvic 12.3 and 13.5, and of caudal fin 17.2 and 19.8.

The following counts were made, respectively: Dorsal rays X-I, 10 and X-I, 11; anal rays II, 11 and II, i, 10; pectoral rays ii, 16–ii, 17 and ii, 17–ii, 17; pelvics I, 5–I, 5 and I, 5–I, 5; branched caudal rays 8+7=15 and 8+7=15; scale rows from upper edge of gill

opening to midbase of caudal fin 78 and 77; scales from origin spiny dorsal to lateral line 8 and 8, and from origin of second dorsal to lateral line 8 and 8; scales from anal origin to lateral line 10 and 9; scales between the two dorsal fins 11 and 11; scales from origin of spiny dorsal to occiput 18 and 19; zigzag scales around least part of caudal peduncle 24 and 24; gill rakers on first gill arch 8+1+21 and 8+1+21.

Body fusiform, greatest depth through base of spiny dorsal; head bluntly pointed; caudal peduncle slender, its least depth equals bony interorbital space; dorsal and ventral profiles about equally curved; snout nearly equal to orbit but a little shorter than postorbital length of head; interorbital space slightly convex; lateral line complete, continuous to at least halfway out middle rays of caudal fin; body covered with small ctenoid scales, these continuing on head covering operculum, preorbital and top of head to in front of nostrils; tip of snout and area from front of eye to tip of snout, gill membranes, and lower jaw, not scaled; middorsal line and midventral line evenly scaled over, no crowding of scales; pelvics with a long accessory scaly appendage reaching halfway the length of the pelvic fins; base of pectoral fins fully scaled, these scales continuing out along the rays for about two-thirds their length; caudal fin scaled out about four-fifths its length; base of soft dorsal fin and soft anal fin with a scaly sheath, one scale wide but no scales on the rays or membranes, these fins partly hidden between the sheath when depressed; origin of spiny dorsal at a vertical line near middle of length of pelvics; a vertical line passes through the origins of both second dorsal and anal fins; pectorals rather short, equal to snout and eye, not quite reaching as far back as tips of pelvics, the latter reaching to under the base of the sixth dorsal spine; last ray of soft dorsal and anal fins a little elongated; pectoral fins and lobes of caudal fin pointed; posterior or distal margin of spiny dorsal fin slightly concave or truncate; distal margin of soft dorsal and anal fins truncate to very slightly concave; gill rakers slender; teeth minute, probably in a single row on premaxillaries, obsolete or absent on lower jaw; no teeth on vomer, pterygoids or tongue; dentary with a high leaflike lobe extending dorsally, so that when mouth is widely opened this forms inner side of mouth; premaxillaries excessively protractile, the ascending process reaching a little past orbits when mouth is closed; preopercle with thin membraneous edge, the lower corner extended to form a projecting lobe, its edge with thin, flexible serrae; opercle ending in a short, thin flat spine; upper edge of shoulder near upper part of gill opening with a notch; nostrils paired, somewhat near together but well separated by a narrow dermal isthmus between anterior and posterior ones; anus some distance in front of anal origin but closer to the latter than to tips of pelvic fins; longest gill raker about equal to distance that posterior nostril is from eye.

Color (in alcohol) light brownish, paler below, midline of back with a brownish streak and two more narrow brown streaks between it and the lateral line, and possibly one or two more narrow brown streaks below lateral line anteriorly, but these are hardly discernible now; inside of gill cover rather heavily black pigmented; top of head with numerous small brown specks. A small dark brown elongate spot, two-thirds the way out on the lower two rays of the lower lobe of caudal fin in the paratype, is absent in the holotype.

This new species differs from all other genera and species in the family Emmelichthyidae as diagnosed in the key below. It was named *atlanticus* because of its occurrence in the Atlantic Ocean and because it undoubtedly will be found to be a pelagic species of wide distribution in this ocean. It should be noted that specimens of most of the species referred to this family are very scarce in museum collections.

Key to Genera of Emmelichthyidae Related to Emmelichthyops

1*a*. Maxillary slipping for most part under and almost wholly concealed by preorbital.
  2*a*. Spinous and soft dorsal fins connected, scarcely emarginate or not emarginate between spiny and soft part; last rays of soft dorsal and anal fins elongate or with last ray as long as next to last rays.
    3*a*. Soft dorsal and anal rays shorter than spines, and when fins are depressed soft rays concealed in scaly sheath at base of rays; body deep, compressed, depth $2\frac{1}{5}$ to $2\frac{1}{3}$ in standard length; vomer toothless; dorsal rays XII, 16; anal III, 15 or 16; gill rakers on lower part of first arch 14 or 15; maxillary scarcely reaching to under front of eye. *Coleosmaris* Norman

3*b*. Soft dorsal and anal fins not especially short, and when fins are depressed soft parts not concealed by scaly sheath at base.

4*a*. Outer teeth at front of jaws more or less enlarged, conical, sometimes 2 to 5 pointing forward and more or less flaring outward, at least on adults; vomer with small or minute teeth; dorsal rays XI or XII, 9 to 11; anal III, 7 to 9. . .*Merolepis* Rafinesque

4*b*. No enlarged caninelike teeth at tips of jaws; vomer toothless; dorsal rays X, 15 or 16; anal III, 15 or 16. *Pterosmaris* Fowler

2*b*. Either spinous dorsal separated from second dorsal or fins more or less separated by a deep emargination to base or nearly so at posterior end of spiny part of dorsal fin; body fusiform, not compressed; last rays of soft dorsal and anal fins a little elongated; ascending process of premaxillaries reaches to or nearly to rear of orbits; tip of snout rounded, without concave notch; each pair of nasal openings separated by a narrow dermal isthmus.

5*a*. Dorsal fins completely separated, intervening space scaled over, this space slightly greater than postorbital length of head; dorsal rays X-I, 10 or 11; anal II, 10 or 11. . .*Emmelichthyops*, n. gen.

5*b*. Spiny and soft parts of dorsal fin not completely separated, the intervening space, if present, not scaled over.

6*a*. Posterior spines of dorsal connected by a membrane; dorsal XVI or XVII, I, 9 or 10; anal II or III, 8 or 9. . . . .*Inermia* Poey

6*b*. Posterior spines of dorsal fin more or less isolated, scarcely connected by a membrane; dorsal XII-I, 10; anal III, 10. . . . *Centracantus* Rafinesque

1*b*. Maxillary almost wholly exposed, its dorsal edge scarcely slipping under preorbital,

7*a*. Tip of snout convex over premaxillary, without a convex notch.

8*a*. Spiny part of dorsal shorter than soft part; dorsal rays X or XI, 25 to 27; anal rays III, 23 or 24. *Cypselichthys* Steindachner and Döderlein

8*b*. Spiny part of dorsal fin longer than soft part; dorsal rays XIII to XV, I, 9 to 11; anal rays III, 9 to 12; last ray of spiny dorsal notably longer than next to last rays; a deep emargination in front of last dorsal spine, the next to last 4 or 5 spines short; nostrils separated by a narrow dermal isthmus; maxillary naked; body fusiform but somewhat compressed; last rays of soft dorsal and anal probably not elongated. *Dipterygonotus* Bleeker

7*b*. Tip of snout with a concave shallow notch above tip of premaxillaries; last rays of soft dorsal and anal fins not elongated; preopercle with a somewhat posteriorly produced rounded lobe; body somewhat compressed; maxillary scaled; spiny part of dorsal longer than soft part; nostrils especially close together; opercle with two flat spines, concave between them.

9*a*. Last spine of dorsal notably longer than next to last spine, the spiny dorsal with a deep emargination in front of last dorsal spine, but fin more or less continuous; no teeth on vomer; dorsal rays X, I, 11; anal III, 9 or 10. *Erythrocles* Jordan

9*b*. Last spine of dorsal fin not longer, usually about same length as next to last spines of dorsal.

10*a*. Dorsal fins continuous but with a moderately deep emargination posteriorly in spiny part of fin; minute teeth on vomer; dorsal rays XII, 10 or 11; anal III, 9. *Plagiogeneion* Forbes

10*b*. Dorsal fin with posterior IV or V spines isolated, probably not connected by a membrane; vomer toothless; nostrils separated by a dermal isthmus; dorsal rays XIII, 10 or 11; anal III, 9 or 10. *Emmelichthys* Richardson

Genus **Coleosmaris** Norman

Coleosmaris Norman, Ann. Mag. Nat. Hist. (ser. 10) **7**: p. 359, fig. 4, 1931 (type—*Coleosmaris nigricauda* Norman) (Accra, Gold Coast, Africa).

This genus contains but one species, *Coleosmaris nigricauda* Norman, from off the African Gold Coast. I have not examined a specimen, but the generic diagnosis is from Norman's figure and description.

Genus **Merolepis** Rafinesque

Merolepis Rafinesque, Indice d'ittiologia siciliana, p. 25. May 1810 (type—*Sparus massiliensis* Lacepède = *Sparus zebra* Brünnich) (ref. copied).

Maena Cuvier, Règne animal (ed. 2) **2**: 185. 1829 (type—*Sparus maena* Linnaeus) (ref. copied).

Mena Swainson, Natural history of fishes . . . or monocardian animals **2**: 170, 215. 1839 (type—*Sparus maena* Linnaeus).

Spicara Rafinesque, Caratteri di alcuni nuovi generi e nuove specie . . . Sicilia, p. 51. 1810 (type—*Spicara flexuosa* Rafinesque = *Sparus smaris* Linnaeus).

Smaris Cuvier, Bull. Sci. Soc. Philom. Paris, p. 92. 1814 (type—*Sparus smaris* Linnaeus) (preoccupied).

Marsis Barnard, Ann. South African Mus. **21**: 682. 1927 (type—*Sparus smaris* Linnaeus) (new name to replace *Smaris* Cuvier, preoccupied by *Smaris* Latreille, 1796, in Arachnida).

I have examined 25 specimens, U.S.N.M. 2259–2263, 5384, 6053, 2966, 29743, 37241, 45051, 48336, 48337, and 48373 belonging to this genus, on which I have checked the characters given in the key. This genus is treated by Fowler in volume 2, p. 860, of his "The Marine Fishes of West Africa," published in 1936.

Rafinesque's descriptions are so very incomplete one cannot be certain of the species he had.

Barnard (*l.c.*) refers *Smaris australis* Regan to this genus in addition to the genotype.

Genus **Pterosmaris** Fowler

Pterosmaris Fowler, Amer. Mus. Nov., No. 162: 4. 1925 (type—*Smaris melanurus* Valenciennes).

The only species referred to this genus is the genotype, which I have not examined. Perhaps it should be treated as a subgenus along with *Spicara* Rafinesque.

Genus **Inermia** Poey

Inermia Poey, Mem. Hist. Nat. Cuba **2**: 193. 1861 (type—*Inermia vittata* Poey).

Four specimens (U.S.N.M. 21253, 33121, and 33124) from Cuba and one (B. O. C. 235) from Cay Sal Bank are *Inermia vittata* Poey, and from them the characters used in this key were described. Only one species is known.

Genus **Centracantus** Rafinesque

Centracantus Rafinesque, Caratteri di alcuni nuovi generi e nuove specie . . . Sicilia, p. 42, pl. 10, fig. 1. 1810 (type—*Centracantus cirrus* Rafinesque).

Centracanthus Rafinesque, Indice d'ittiologia siciliana, p. 18. 1810 (type—*Centracantus cirrus* Rafinesque) (ref. copied).

Centracantha Rafinesque, *ibid.*, p. 67 (type—*Centracantus cirrus* Rafinesque) (ref. copied).

I have examined two specimens, U.S.N.M. 94455 and 123195, which belong to this genus.

Fowler, in his "Marine Fishes of West Africa," volume 2, p. 862, 1936, discusses this genus. I am removing *Spicara* from Fowler's list of synonyms of this genus on the basis of dentition and placing it with *Merolepis*.

Genus **Cypselichthys** Steindachner and Döderlein

Cypselichthys Steindachner and Döderlein, Denkschr. math.-nat. Akad. Wiss. Wien **48**: 14, pl. 7, fig. 1. 1883 (type—*Cypselichthys japonicus* Steindachner and Döderlein).

The genotype is the only species referred to this genus. I have not examined a specimen but have taken my generic diagnosis from the original description and figure of *C. japonicus.*

Genus **Dipterygonotus** Bleeker

Dipterygonotus Bleeker, Journ. Indian Archipelago **3**: 71. 1849 (type—*Emmelichthys leucogrammicus* Bleeker).

I have examined two specimens, U.S.N.M. 126386 and 56238, which belong to this genus. They probably are *D. leucogrammicus*, although U.S.N.M. 56238 is in very poor condition and my identification is doubtful. Another species, *D. gruveli* Chabanaud, is referred to this genus. In addition, we have a large series, U.S.N.M. 131113, 1,505 specimens, none of which exceeds 40 mm. in standard length, from Varadero Bay, Mindoro, Philippines, July 22, 1908, *Albatross.*

Genus **Erythrocles** Jordan

Erythrocles Jordan, Proc. Acad. Nat. Sci. Philadelphia, 1918: 342. 1919 (replaces *Erythrichthys* Temminck and Schlegel, preoccupied) (type—*Erythrichthys schlegeli* Bleeker = *Emmelichthys schlegelii* Richardson).

Erythrichthys Temminck and Schlegel, Fauna Japonica, pp. 117, 318, pl. 63, fig. 1. 1845 (type—*Emmelichthys schlegelii* Richardson, designated on p. 318).

I have examined two specimens of *E. schlegelii*, U.S.N.M. 52518 and 62367, from the Hawaiian Islands. From these I have taken the characters used in the key. Besides the genotype, *Erythrichthys scintillans* Jordan and Thomson belongs in this genus.

Genus **Plagiogeneion** Forbes

Plagiogeneion Forbes, Trans. New Zealand Inst. **22**: 273. 1890 (type—*Therapon rubiginosus* Hutton).

Plagiogenion Forbes, *in* Fowler, U. S. Nat. Mus. Bull. 100, **12**: 350. 1933 (error in spelling) (type—*Therapon rubiginosus* Hutton).

Two species are referred to this genus: *Plagiogeneion rubiginosus* (Hutton) and *Plagiogeneion macrolepis* McCulloch. I have not seen a specimen of either.

Genus **Emmelichthys** Richardson

Emmelichthys Richardson, Voy. *Erebus* and *Terror*, Fishes, **2**: 47. 1844 (type—*Emmelichthys nitidus* Richardson).

Boxaodon Gay, Historia fisica y politica de Chile, Zoologia, **2**: 208. 1848 (type—*Boxaodon cyanescens* Gay).

The species in this genus are *Emmelichthys nitidus* Richardson and *Boxaodon cyanescens* Gay. I have examined three specimens of *E. nitidus*, U.S.N.M. 48817, from which the characters used in the key have been taken.

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JOURNAL

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VOLUME 35 MAY 15, 1945 No. 5

GEODESY.—*The utility of geodetic control surveys.*[1] CLEMENT L. GARNER, U. S. Coast and Geodetic Survey.

Geodetic surveys are surveys employed over areas of large extent for which the curvature of the earth must be taken into consideration. Since the curvature depends on the size and shape of the earth, every geodetic survey of necessity is based on some spheroid of reference that has been adopted for that particular part of the earth's surface.

FIGURE OF THE EARTH

The determination of the size and shape of the earth has engaged the attention of many of the leading thinkers of the centuries, but it was not until the early nineteenth century that the problem may be said to have been solved sufficiently to meet most practical problems in surveying and engineering. Extensive investigations since that time have resulted in a number of determinations, succeeding ones generally having the advantage of being based upon more widely distributed data. The exhaustive work of Hayford published in 1910 undoubtedly most nearly represents the true dimensions of the earth so far determined. The accuracy of this work is evidenced by the fact that in 1924 the International Union of Geodesy and Geophysics recommended the International Ellipsoid (the Hayford Ellipsoid with slight modification) for use by all countries that were in a position to adopt it.

Yet we find several different spheroids in use over the world today. For practical purposes and within certain bounds these are undoubtedly adequate. But complications arise in regions such as Europe where owing to different spheroids the problem of determining the relation between coordinates at the boundaries of the countries involved is most serious. In North America the Clarke spheroid of 1866 had been adopted by Canada, Mexico, and the United States before the International Ellipsoid was recommended by the International Union of Geodesy and Geophysics in 1924. To change would be prohibitive because of the great amount of surveys already accomplished.

Great progress has been made in the United States and Alaska during the past 15 years in the extension of arcs of triangulation into new areas. These with the work completed in other parts of the world will afford an excellent opportunity for further research at the first opportunity following the war. While formerly the problem of greatest geodetic importance was the determination of the figure of the earth, now we are more concerned with the practical uses of geodetic surveys as engineering and suveying tools. Obviously the value of any tool depends largely upon its availability.

The triangulation network in the United States today has at least approached the condition where one may readily realize the adaptation of the data to its manifold uses in our economic and industrial existence. Fortunately we have lost little by obsolescence. The basic framework started by Hassler in 1816 conforms well to the demanding requirements of today although accomplished with instruments and equipment that would now be considered crude. This is tribute to Hassler's vision in preparing the groundwork for geodetic operations in this country. It was in 1927, over 100

[1] Address of the Retiring President of the Washington Academy of Sciences delivered at the 331st meeting of the Academy on February 15, 1945. Received February 21, 1945.

years from the beginning, before the triangulation had assumed the proportions of a basic framework susceptible of adjustment into a rigid whole. The increased interest in the use of geodetic control is significantly illustrated by the fact that of the more than 100,000 triangulation stations in the United States today, nearly three-fourths of them have been established in the past 15 years. This condition also applies roughly to other geodetic operations.

PRACTICAL USE

Everyone realizes the vast demands for surveying and mapping created by war. This condition was experienced also in World War I and contributed materially to the increased activity in all classes of mapping in this country in the interval leading up to our entry into World War II. Since then the needs have been unprecedented, and all regular Federal mapping agencies have cooperated with the military departments in meeting the requirements for surveys and maps. It must be recognized that under such conditions the compilation of many types of maps, as for example, aeronautical charts, had to be accomplished as would best meet the emergency and could not wait for the completion of geodetic control. Otherwise extensive use has been made of geodetic surveys in order to maintain complete coordination not only for mapping in this country and Alaska but also in various defense installations at coast and island bases and in the solution of various fire-control problems.

We are here principally concerned with their usefulness as required in our peacetime pursuits. Very briefly, the most essential applications are:

1. For all general surveys of large areas, such as for large-scale mapping, flood control, reclamation, forest inventory or where coordination and permanence of location must be had at the same time.

2. Settlement of boundaries. The use of geodetic control in the referencing of property boundary surveys, although nothing new, is only beginning. When stations become available within reasonable reach of the local surveyor without too much cost to his client, every property owner will desire to reference his surveys to existing monuments that are everlasting and thus insure the retracement of his property boundary lines by competent surveyors at any future time. Such safeguards will result in savings of great sums of money now spent annually in litigation of such matters.

3. Surveys required in city planning. Recently there has been a continually increasing use of precision geodetic surveys for city planning as needed to obtain overall accuracy of the many surveying projects which with time are liable to become rather heterogeneous in metropolitan regions. Several of our large cities now have such surveys and others are anxious to obtain them.

4. Surveys to determine crustal movement, such as that caused by earthquakes, the lowering of ground water level, or in the study of settlement problems such as that caused by the water load at Lake Mead just above Boulder Dam. Here a network of leveling was first accomplished in 1935 before the lake had started filling and the second in 1940, five years later when the water had reached a reasonable height. The results so far show that some changes have taken place, but it is probable that the full effect of the water load will not be evidenced for some years. It is therefore anticipated that levels may be run over the network at suitable intervals to determine further settlement with the passage of time. Precision horizontal angle observations also were made on the marked points on the downstream race of the dam and in the construction on either side of the stream for the purpose of studying problems of structural movement.

5. Precision measurement of base lines or distances as, for example, the measurement of the Pasadena Base and the triangulation between this base and two stations on the mountains between which Michelson made his experiments in determining the velocity of light.

6. For special horizontal alignment and in precise leveling such as that required in the work of the David Taylor Model Basin at Carderock, Md.

7. For the determination of great circle distances between airports which are being used extensively by aviation authorities in

scheduling uniform tariffs for passenger and freight service in this country and in many other parts of the world.

Clearly one function of geodetic control surveys is that of coordination—that is, in making ties to other acceptable control surveys and adjusting them to the national net, thus making them available for general use. Such work forms a very important and valuable addition to the national net.

It is to the interest of all that stations be located where they are least likely to be molested or destroyed and also where they will not interfere with probable improvement or construction. The total cost and value of control surveys at any time are represented by existing stations and bench marks and every effort is made to establish permanent marks easily recoverable.

With some 25,000 monumented triangulation stations and more than 225,000 bench marks, the job of maintenance alone assumes considerable magnitude. Scores of stations and bench marks are lost every year. The problem of maintenance is to keep the loss as low as possible by having lost marks replaced by our field parties and by enlisting the cooperative assistance of a large number of engineers and surveyors engaged in both public and private work. Such people are very public-spirited and generally are pleased to do the work free, since Uncle Sam, prodigal in many ways, has no money for this.

Some have questioned the need for high accuracy in the geodetic control when many of its important uses can be served as well with less accurate work. For many problems such as obtaining a basic framework and for property boundary surveys, the work of high precision is absolutely essential and it is important to bear in mind that one job well done, and at only slightly more cost than less accurate work, serves all purposes equally well indefinitely.

In re-triangulation and re-leveling to determine earth movement resulting from seismic disturbance or in the relocation of lost stations one comes at once to the very heart of the question of accuracy. With what accuracy were those stations or bench marks located or replaced? The answer must be obtained from an analysis of the several actors affecting the accuracy of the final data which may be classified under the following general items:

1. Quality of instrument.
2. Observational procedure.
3. Refraction.
4. Phase and eccentricity.

INSTRUMENTS

Many excellent theodolites suitable for present-day precise triangulation are manufactured (or were before the war) by a number of instrument makers in the United States and in Europe. The horizontal circles of these theodolites vary in diameter from 5 to 9 inches and can be read with micrometer attachment to single seconds, sometimes to tenths of seconds. Most such instruments are small and compact and weigh only 15 to 28 pounds without carrying case and are easily transported from station to station even when backpacking is necessary.

Naturally, for precision triangulation it is most important that the instrument circle be of proved accuracy. This must be obtained from tests simulating field conditions as far as practicable except as regards refraction. This is best accomplished in a testing room where permanent collimators at 15 to 25 feet from the instrument take the place of distant stations as observed in the field. Tests are made on all new instruments before they are sent to the field and whenever they are returned for overhaul. The latest circle tests show that the maximum probable graduation errors are not in excess of 1.5 seconds and, since observations are distributed over the entire circle, graduation errors have little effect on the results.

OBSERVATIONAL PROCEDURE

Observing procedure has been developed with the view of eliminating instrumental and personal errors insofar as practicable. The observations are made from 16 positions of the circle. For every direction taken with the telescope in the direct position there is one with the telescope in the reverse position. A horizontal angle is obtained from the mean value of a minimum of 32 pointings of the telescope on each station for which there are 128 micrometer readings.

REFRACTION

Without question lateral refraction is the greatest source of trouble in triangulation. It is a potential danger constantly to be guarded against. Experience shows that it is nearly always present when there is much cooling of the ground, but the amount is variable and unpredictable. It has been found particularly bad at night when cold winds blow over dry hot ground or surface rocks that are giving off the heat absorbed from the sun during the day. The slope and vegetation of the terrain and its nearness to the ray greatly affect the bending. Some observers claim to have experienced as much as 15 seconds horizontal refraction under severe conditions. However, the greatest amount experienced under normal conditions of observations and proved by triangle closure of which we have knowledge was between 7 and 8 seconds. Stations and towers must be so located that rays to other objects will not pass close to houses, tree trunks, or tripod legs. Triangulation in cities quite frequently is difficult because of refraction caused by heat and smoke from chimneys. There are certain phenomena that an experienced observer recognizes as indicating the existence of a disturbed condition. Otherwise there is not much to be done about it except to go ahead and observe when other conditions permit.

In observing vertical angles it is well known that the refraction is rather variable especially near sunrise or sunset, and sometimes it is very erratic. Furthermore, owing to the extreme condition of cloudiness during some seasons, or in some regions such as Alaska, it becomes necessary to make the observations whenever they may be obtained, generally at night. For these reasons trigonometric leveling can not be expected to produce precision results and such observations are made only where elevations cannot be determined by other practicable means.

Spirit leveling is also seriously affected by vertical refraction, and therefore every effort is made to eliminate or reduce it to a minimum. The program is planned to vary the conditions under which the backward and forward lines are run with reference to the direction of wind and sun, and in all probability the effect of refraction is eliminated on level ground. In leveling up steep grades where the upgrade sight is always near the ground while the downgrade sight is far from it, there is a differential in the amount of refraction which is extremely difficult to control.

PHASE AND ECCENTRICITY

Phase is particularly troublesome in daylight observations when the appearance and shape of objects are altered owing to the change in the direction of the sunlight on them. Observations for first and second-order triangulation are practically all made on electric signal lamps at night and this procedure largely overcomes the problem of phase. Furthermore, since each lightkeeper is required to point the center of the beam of his lamp to the observer, there is no eccentricity except what might be due to the imperfection of the reflector. Observations made at night are more accurate than those made during the daytime because the atmospheric conditions are better generally and there is less difficulty from lateral refraction. As a rule daylight observations are made only on chimneys, water tanks, cupolas and other identifiable objects. These probably are affected to some extent by phase though precautions are taken to guard against it insofar as practical. Such points, moreover, are used for photogrammetric and other control and are not considered as first-order.

Another problem is that of eccentricity. All horizontal angle observations should be made with the instrument and the lamps, heliotropes or other signals centered perfectly over the stations. This is not as simple as it may seem and frequently becomes of critical importance. The shorter the lines the greater the care required in centering the instrument and the objects sighted upon.

TRIANGLE CLOSURE

On first-order triangulation it is required that the average triangle closure shall not exceed 1 second and that no closure shall exceed 3 seconds. A further

check is that the logarithm of the length of the sides of the triangulation as determined by the different triangles through which the computations are carried shall not exceed three times the difference for 1″ of the logarithm for the smallest angle entering the computation.

LIMIT OF ERROR

The errors that may be caused by instrumental or observational imperfections are controlled within very narrow limits. Divergences from the true values evidently are caused by erratic and unusual conditions and do not occur frequently. Where they do occur the safeguard against them is the maximum allowable triangle closure of 3″, which requires that the faulty observations must be repeated until acceptable results are obtained. Experience shows that 10 percent of the stations have to be reoccupied in obtaining first-order results. The maximum discrepancy that can be caused by the total allowable error on one or more directions in a single closed figure of triangulation (usually a quadrilateral) depends largely on the strength of the figure.

The accuracy of first-order triangulation can best be estimated by comparing the measured lengths of base lines with the lengths as determined by computation through the triangulation from the preceding base and by triangulation loop closures. It was found from a recent test involving 32 base lines that the average closure on bases is of the order of 1 part in 54,500. The specifications require an accuracy of 1 part in 25,000 which is the largest acceptable limit.

Only a very brief discussion of the leveling net will be given. The net consists of more than 225,000 bench marks distributed over more than 300,000 miles of lines in the United States.

The specifications for first-order leveling are that the forward and backward runnings of a section shall not differ by more than 4 mm $\sqrt{K}$ where K is the length of the section in kilometers. An indication of the accuracy is the fact that the average correction applied in distributing the adjusted loop closures is of the order of 0.1 mm per kilometer or 1 cm in 62 miles.

GRAVITY DETERMINATIONS

Gravity observations properly distributed over the surface of the earth form an excellent means of determining the shape of the earth and were used very extensively for that purpose until the beginning of the war when operations in many countries including the United States were suspended. Differences between actual and theoretical gravity (anomalies) are sometimes quite large and are presumed to be due to lack of isostatic adjustment or to buried structure or perhaps to both. Such buried structure may consist of salt domes or buried granite ridges, both of which are associated with the location of petroleum. Gravity observations made to determine the shape of the earth and to establish the base stations used in geophysical exploration are made with a pendulum apparatus of which special types have been developed for work both on land and on the sea. Gravity observations used in search of oil and minerals have generally been made with gravimeters of which there are also several types, all of comparatively recent development. These instruments are extremely accurate for local surveys, and observations at a station can be made in only a few minutes. Furthermore, they are easily transported and at small cost.

NORTH AMERICAN DATUM

In 1913 the governments of Canada, Mexico and the United States jointly adopted a common datum of reference for their horizontal control surveys, which was designated the North American Datum. This action was taken in the interest of efficiency and economy to avoid double coordinates at the boundaries and to establish uniformity and continuity in mapping procedure. Representatives of some of the countries of Central America have also expressed a desire to coordinate the geodetic surveys in their countries on the North American Datum. Thus it would appear that the North American Datum

ALASKA

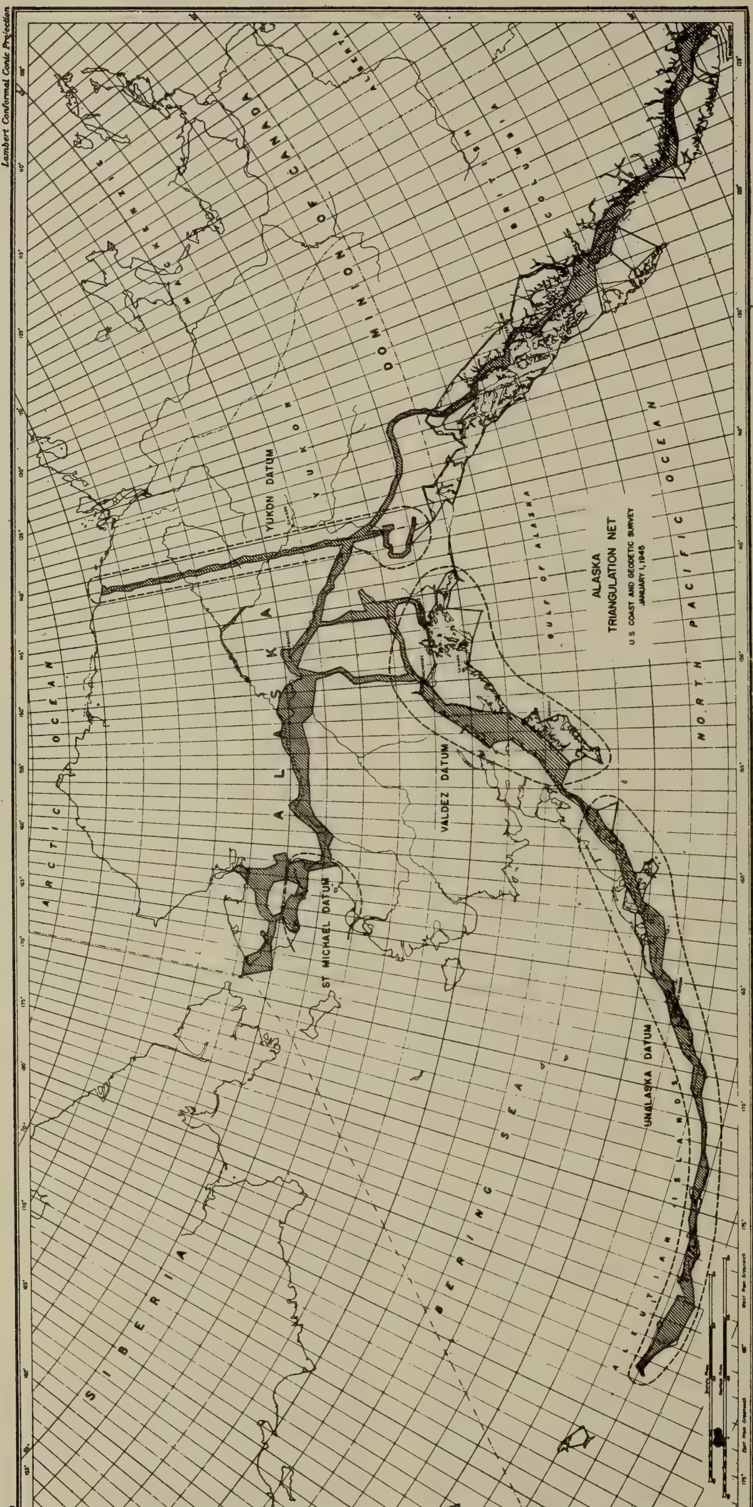


FIG. 1.—Alaska triangulation net.

may eventually be expected to extend all over North America and to a connection to the geodetic work of South America somewhere on the Isthmus of Panama.

At the request of the War Department and through the cooperation of Canada it has been possible during the past four years to extend the North American datum into the interior of Alaska. Through this work what previously were four independent geodetic datums (Yukon datum, Valdez datum, Unalaska datum and St. Michael datum) are now referred to the North American Datum. The triangulation scheme to Alaska follows the Alaska Military Highway, and in fact, was carried on while the road was under construction (see Fig. 1). This single line of communications and travel along the axis of the scheme probably reduced the cost to one-fifth of what it otherwise would have been. Air transportation was required for about 75 percent of all field operations on the work west of Fairbanks. This was accomplished by the use of light float planes of from 200 to 800 pounds capacity which could be landed on small lakes and streams near the stations. By reason of this work there is now a continuous arc of first-order triangulation from Bering Strait, which separates Alaska from Siberia, through Alaska, Yukon, southeast Alaska, British Columbia, the United States, and Mexico to southern Mexico, a distance of approximately 5,400 miles.

WESTERN HEMISPHERE

The events of the past three years have emphasized among other things the need of international cooperation in mapping. Prior to 1941 no concerted action had been taken by countries in the Western Hemisphere in regard to geodetic surveying or in fact concerning any phase of mapping. The situation was very suddenly changed when the war spread to the Western Hemisphere bringing an unprecedented demand for all classes of maps of world coverage, particularly for aeronautical charts.

Another potent factor toward accelerating surveying and mapping in the Western Hemisphere has been the two recent Pan American Consultations on the various branches of cartography, the first of which was held in Washington in October 1943 and the second in Rio de Janeiro August 14 to September 2, 1944. The following is quoted from a report in the January 1945 issue of the Bulletin of the Pan American Union by Robert H. Randall, United States Member and Chairman of the Committee on Cartography, Pan American Institute of Geography and History:

> The American Geographical Society acted as host for the United States, and the Commission on Cartography of the Pan American Institute of Geography and History acted as joint sponsor, and organized the Consultation. Broad lines for the program of mapping improvement in the hemisphere were drawn. The First Consultation was attended by technical representatives from the countries of North and South America. In the Second, all of the American nations with the exception of El Salvador, Haiti and Nicaragua, were represented. The Brazilian Government joined the Pan American Institute in sponsoring the Second Consultation and the general program outlined in the First Consultation was further refined, and specific recommendations as to immediate and future procedure were made.
>
> The nations of the American Hemisphere have, for the most part, always been conscious of the need for more and better map information. The need for maps of certain classes, notably aeronautical charts, has been critical since the beginning of the Second World War. For while the excellent maps compiled by the American Geographical Society were fortunately complete and available for most of Latin America at the beginning of the war, the need of charts for air transport and related purposes made it necessary to fly over and photograph large portions of the Southern Hemisphere. Further, aeronautical charts prepared in some South American localities by the Germans before the war were found to be not only inaccurate but apparently purposely so.
>
> The lack of map information in some areas, and the unreliability of the information in others, called for a tremendous effort in the production of aeronautical charts. The job was undertaken by the United States Air Forces, in cooperation with the other American nations concerned. The series of aeronautical charts which resulted was prepared in a remarkably short period of time. Furthermore, the charts are of such a high standard that they constitute a milestone in the geographic progress not only of the Hemisphere but of the entire planet.

Interest in such matters has been further accelerated by the State Department's program of cultural relations in cooperation with the American Republics in which several Federal departments and agencies are actively cooperating. The Coast and Geodetic Survey has five small projects, three of which consist of the intern training type, which provide for representatives from certain countries to visit the United States and observe our methods of geodetic and hydrographic surveying and of map and chart reproduction. The present program provides for training 21 students each year.

The principal of triangulation, that is, the ability to determine the distance and direction to far distant and inaccessible points without actually going anywhere near them, probably will always be one of fascinating interest. The discovery of this geometric law, although certainly more than 2,000 years old, must have been as epochal in its time as the discovery of electricity or radio in ours. Of this, President Woodrow Wilson in a public address in 1916 said: "I have wished, particularly since I entered public life, that there was some moral process parallel to the process of triangulation so that the whereabouts, intellectually and spiritually of some persons, could be discovered with more particularity."

PHYSICS.—*Faster than sound.*[1] THEODORE VON KÁRMÁN, California Institute of Technology. (Communicated by HUGH L. DRYDEN.)

The modern mathematical theory of flight as worked out in the past three decades is based on the assumption that the air can be considered as an incompressible fluid. At first thought this assumption may appear rather paradoxical, since, while water is considered as the typical example of an almost incompressible fluid, air is justly regarded as the typical example of compressible fluid medium. Nevertheless, the theory of incompressible fluids furnished, for example, good approximations of the forces acting on airplane wings, provided the flight speeds of airplanes are small in comparison with the velocity of sound. The entrance of the velocity of sound into the problem has nothing or very little to do with acoustic phenomena. The term velocity of sound stands for the velocity of propagation of small pressure changes in the fluid medium. If this velocity of propagation is large in comparison with the velocities involved in the fluid motion concerned, it can be considered as being of infinite magnitude as well. However, infinite velocity of sound is the characteristic feature of an incompressible fluid. This explains the success of the classical hydrodynamical theory of incompressible fluids in aeronautics. However, as the airplane became speedier, the deviations from the results predicted by the theory of incompressible fluids became larger and larger. As the flight velocity surpassed approximately two-thirds the velocity of sound, it became evident that the discrepancy between the actual phenomena and the simple theory can no longer be removed by small corrections. The so-called "compressibility effects" became a plague and headache of the airplane designers who were used to thinking in terms of low speed aerodynamics. It appeared necessary to consider the air as compressible and to work out the theory of wings, propellers, and other devices based upon the laws of the dynamics of compressible fluids. This reformulation of aerodynamic theory became a necessity as in our ambitious and air-minded age the speed of airplanes is being pushed up to and perhaps beyond the velocity of sound. The requirements of modern warfare have further accelerated this process.

To be sure, the science of ballistics has dealt for a long time with supersonic flow

[1] The thirteenth Joseph Henry Lecture of the Philosophical Society of Washington, delivered at the 1234th meeting of the Society on April 29, 1944. Received January 27, 1945.

phenomena. However, the speed of projectiles is in general several times the velocity of sound. The mathematical theory for such a case is relatively simple. The great difficulties—both for the mathematical calculations and for the physical understanding—appear in the range which recently was denoted as "transsonic." This is the range of velocities just below and just beyond the velocity of sound, where the air flow pattern contains both regions of subsonic flow and of supersonic flow.

Let us consider for example the law for the resistance of a body moving in a fluid medium. This law can be expressed as a functional relation between certain dimensionless combinations of the velocity of motion, the size of the body, and the physical properties of the medium. Such a dimensionless combination is, for example, the drag force D divided by an appropriately chosen sectional area S of the body, the density ρ of the medium and the half of the square of the velocity v. It is evident that $\rho v^2/2$ has the dimension of pressure; as a matter of fact, it is equal to the stagnation pressure of an incompressible fluid moving with the velocity v and having a density equal to ρ. Hence, the surface S multiplied by $\rho v^2/2$ has the dimension of a force. The dimensionless combination $D/[S(\rho v^2/2)]$ is called the drag coefficient and is a function of two other dimensionless combinations which are known as the Reynolds number and the Mach number. The Reynolds number expresses the relative influence of the inertial and the frictional forces. The Mach number expresses the influence of compressibility. It is defined as the ratio between the velocity of a motion or a flow and the velocity of sound. Now, experience and theory show that as long as the "Mach number of the motion," i.e., the ratio between the velocity of motion of the body and the velocity of sound in the medium, is small in comparison with unity it has no significant influence on the drag. If the Mach number reaches values comparable with unity, the compressibility of the air has very large influence on the drag and other aerodynamic characteristics of the body. To be sure, the Mach number remains the governing factor over the entire supersonic range; however, if the velocity of the moving body is considerably higher than the velocity of sound, aerodynamic coefficients change with the Mach number at a moderate rate and the flow pattern retains its general character. In the range of velocities slightly lower and slightly higher than the velocity of sound radical changes in the flow pattern take place and the phenomena are much more complex than in the pure subsonic and pure supersonic ranges, essentially because regions of subsonic and supersonic flow are coexistent. This speed range is designated as the transsonic range.

The magnitude of the velocity of sound in a fluid medium is determined by the equation $c^2 = dp/d\rho$ where p is the pressure and ρ is the density of the medium. The pressure p is considered in this equation as a function of the density ρ. It is assumed that the change of density with change of pressure is fairly well approximated by the relation corresponding to adiabatic change. The easiest way to obtain the expression for the velocity of sound is based on the consideration of the propagation of a small pressure change from the viewpoint of an observer who moves with the propagating front. For such an observer the motion of the fluid appears as stationary flow; the fluid appears moving through the front with the velocity of sound in a direction opposite to the direction of propagation. Let us denote the pressure increment through the front by dp and the corresponding increment of the density ρ by $d\rho$ and the velocity of the fluid moving against the front by c; then according to Bernoulli's equation for stationary flow the velocity c changes as the fluid passes through the front by the amount

$$dc = -\frac{1}{c}\frac{dp}{\rho}\cdot \qquad (1)$$

Now, since $c\rho$ is the mass of fluid passing through the front in unit time, the continuity of matter requires that the product of density and velocity remains constant. Consequently, $c\rho = (c+dc)(\rho+d\rho)$ or $cd\rho + \rho dc = 0$ and therefore

$$dc = -\frac{c d\rho}{\rho}. \qquad (2)$$

Combining the two equations we obtain $c^2 = dp/d\rho$. Hence, the velocity of propagation of an infinitesimally small pressure increment dp is equal to $\sqrt{dp/d\rho}$ as indicated above. Substituting the value of the derivative $dp/d\rho$ from the equation of the adiabatic change $p = \text{const } \rho^\gamma$, where γ is the ratio of the specific heats of the medium at constant pressure and constant volume, we have $c^2 = \gamma p/\rho$.

Newton gave an expression for the velocity of sound in air, which in modern language amounts to the formula $c^2 = dp/d\rho$. In his calculation of the value of c, he used the relation $p = \text{const. } \rho$ (isothermal law). We can not blame him for this, since in his time the equivalence of heat and work was not yet recognized. However, he noticed that his value was too small in comparison with the measured value, which was obtained by observation of gun shots. He tried to apply certain corrections in order to reconcile theory and experiments. The real reason for the discrepancy was found almost a hundred years later by Laplace.

With $c^2 = \gamma p/\rho$, the square of the Mach number of a fluid flow or a moving body can be expressed by the following combination of velocity, pressure, and density:

$$M^2 = \frac{v^2}{c^2} = \frac{\rho v^2}{\gamma p}. \qquad (3)$$

Perhaps the two most important basic problems of fluid mechanics applied to engineering are the flow of a fluid in a conduit and the motion of a solid body in a fluid medium at rest. In both cases we find certain interesting facts in the transsonic region, i.e., when the velocity of the fluid in the conduit changes from subsonic to supersonic or the velocity of the moving body passes through the velocity of sound. We will see that these peculiar phenomena in the two cases are interconnected, and as a matter of fact, engineering ingenuity was necessary to obtain supersonic flow in a conduit, and engineering ingenuity will be necessary to design airplanes flying with a speed greater than the velocity of sound. However, the difficulty in the first case was surmounted when engineers recognized the fundamental laws of supersonic flow, whereas the difficulties to be surmounted for transsonic flying require the solution of intrinsically difficult problems in power plants and airplane design. Let us consider first the problem of flow through a conduit.

If we mount a so-called simple rounded orifice on the wall of a pressure vessel and observe the efflux of a gas, we find the following results: As long as the pressure difference between the inside and outside pressure is small in comparison to the inside pressure, the velocity of outflow obeys approximately Torricelli's law. It is equal to $\sqrt{2gh}$, where h is the pressure height. The rate of flow is equal to the cross-sectional area of the orifice multiplied by this velocity. If the pressure difference is increasing, the quantity of outflow gradually lags behind the value given by this rule. At a certain value of the ratio between inside and outside pressure the quantity of efflux reaches a maximum. We call this pressure ratio the *critical pressure ratio*. Its value is given by the equation

$$\frac{p_c}{p} = \left(\frac{\gamma+1}{2}\right)^{\gamma/\gamma-1}.$$

If the outside pressure is lowered further, while the nozzle pressure is kept constant, the velocity and the rate of efflux remain unchanged. A simple calculation shows that the velocity in the orifice is equal to the velocity of sound corresponding to the pressure and density prevailing in the orifice. This experience led quite a few engineers of the nineteenth century to the conclusion that the velocity of flow from a pressure vessel to the outside atmosphere cannot be greater than the velocity of sound.[2] It is known that the Swedish engi-

[2] St. Venant and Wantzel (1839) derived the correct relation between velocity and pressure in a compressible fluid. They determined the maximum value of the efflux, but did not give a full picture of what happens when the pressure ratio is larger than critical. Since the application of their formula to the pressure ratio exceeding the critical value would indicate a decrease of the efflux with increasing pressure ratio and zero efflux into vacuum, they made the hypothesis that when the ratio between inside and outside pressure is supercritical, the pressure on the orifice is not

neer Carl Gustaf Patrick DeLaval showed by practical experiments that this is not true. If we employ a converging-diverging nozzle, much higher velocities can be obtained. The maximum velocity corresponds to outflow into vacuum and is equal to

$$V_{max} = \sqrt{\frac{2\gamma}{\gamma - 1} \frac{p_c}{\rho_c}}$$

where p_c and ρ_c are the pressure and density in the pressure chamber. This value is for air about 2.235 times larger than the velocity of sound corresponding to the pressure and density prevailing in the vessel, and 2.450 times larger than the velocity of sound prevailing at the "throat" of the nozzle. The "local Mach number" of the flow itself, i.e., the ratio between the velocity of flow and the velocity of sound prevailing at the same location, increases to infinity since the velocity of sound in vacuum is theoretically zero.

The reason for the necessity of a converging-diverging nozzle becomes evident if we combine Bernoulli's equation for adiabatic frictionless flow and the equation of continuity. Then it appears that the product of the velocity and density reaches a maximum value at a certain value of the pressure. According to the continuity equation, the product of cross-sectional area, velocity and density is constant along the nozzle. Consequently the maximum value of density times velocity corresponds to a minimum value of the cross section. The maximum value of $v\rho$ is given by the equation $d(v\rho) = 0$, or

$$\frac{dv}{v} + \frac{d\rho}{\rho} = 0. \qquad (4)$$

If we combine this equation with Bernoulli's equation written in the form $dp/\rho = -vdv$ and eliminate dv we obtain $v^2 = dp/d\rho$, i.e., the square of the velocity in the minimum cross section, in the so-called "throat," is equal to $dp/d\rho$, i.e., to the square of the local velocity of sound. Whether the velocity be larger or smaller than the velocity in the throat, the same amount of mass flow requires a larger cross-sectional area than the throat area.

Table 1 shows the comparison between the equations for incompressible and compressible fluids. Fig. 1 illustrates the relation between cross section and velocity for an incompressible fluid (curve a) and for a compressible fluid expanding adiabatically (curve b). The equation for the cross section S can be written in the form:

TABLE 1

	Incompressible fluid	Compressible fluid
Continuity.........	$Sv = \text{Const.}$	$S\rho v = \text{Const.}$
Differential form....	$dS/S + dv/v = 0$	$dS/S + d\rho/\rho + dv/v = 0$
Bernoulli's equation.	$dp/\rho + vdv = 0$	

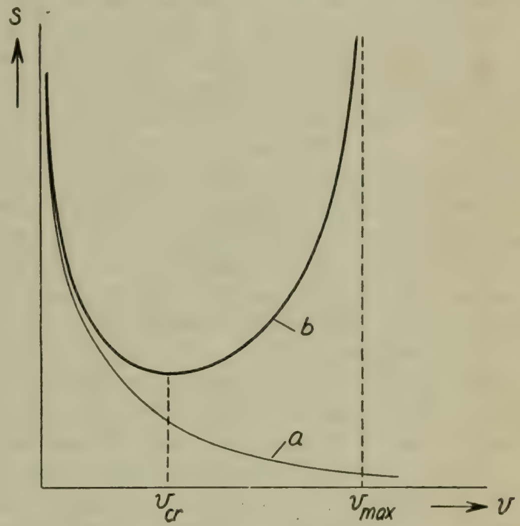


FIG. 1.—Relation between cross section and velocity for an incompressible fluid (curve a) and for a compressible fluid expanding adiabatically (curve b).

$$\frac{dS}{S} = \frac{dv}{v}(M^2 - 1)$$

where $M = v/c$ is the local Mach number. It is seen that dS is positive for positive

equal to the outside pressure. This hypothesis was discussed pro and con in the engineering literature of the following decades. It seems that Osborne Reynolds (1886) was the first author who completed the theory both for the case of a simple orifice and that of the convergent-divergent nozzle.

values of dv when $M>1$, and negative when $M<1$.

We do not want to discuss here the application of the mechanics of compressible fluids to the design of machines like compressors and steam and gas turbines. However, it is necessary to point out an essential difference in the behavior of a converging-diverging nozzle in the subsonic and supersonic range. The nozzle shown in Fig. 2 is designed for a certain pressure ratio p_o/p_e, which is larger than the critical. If the computed pressures prevail at the inlet and outlet, we obtain a flow with adiabatic expansion of the gas from the pressure p_o to p_e; the flow is supersonic between the throat and the outlet. Let us now consider the behavior of the fluid when the pressure at the outlet is raised, whereas the pressure at the inlet is kept constant. We start with a small value of the pressure difference. In this case the gas behaves approximately as an incompressible fluid. The velocity reaches a maximum value at the throat and the expanding portion of the nozzle acts as a diffuser in that kinetic energy is transformed into pressure. As the pressure ratio reaches its critical value (at an exit pressure equal to p_e') the velocity at the throat reaches the value of the local velocity of sound. If we decrease the outlet pressure below the value p_e', we observe the following phenomena. The gas after passing through the throat continues its acceleration, the pressure drops, the velocity increases until at a certain cross section the pressure suddenly jumps to a higher value; at the same time the density undergoes a sudden increase and correspondingly the velocity decreases. We call this phenomenon a "compression shock." Such a compression shock can occur either inside the nozzle mostly as a "normal shock" or starting from the rim of the outlet section as a so-called oblique shock. Sometimes we observe an oblique shock also inside the nozzle. In such a case the flow separates from the wall so that the main flow occupies the center part of the nozzle and a certain space in the neighborhood of the walls is filled with eddying fluid.

The theory of compression shocks for ideal fluids has been worked out theoretically by several scientists in detail. However, the experimental research shows considerable variance with the simple theory mostly due to the friction at the wall. We know that strictly speaking the velocity of the fluid is zero at a solid surface and increases gradually in the boundary layer until the full value prevailing in the main flow is reached. Consequently, even if the main flow is supersonic, near the wall we always have subsonic flow. This fact alone is sufficient to show why the theory of ideal fluids can not explain all phenomena connected with compression shocks. The experimental research in this field is yet in the early beginning stages. The main conclusion we draw from theory and observations is the different behavior of the fluid in the subsonic and supersonic range as far as flow against increasing pressure is concerned. In subsonic flow, i.e., when the velocity at no place surpasses the velocity of sound, we are able to transform pressure into velocity and retransform velocity into pressure in a continuous manner. To be sure, the retransformation of kinetic energy into pressure involves more loss than the transformation of pressure into kinetic energy, but it occurs without discontinuous change in either pressure or velocity. However, if the velocity once surpassed the velocity of sound, in general we are unable to carry out the retransformation of the kinetic energy into pressure without sudden change and this sudden change involves undesirable transfer of mechanical energy in heat instead of pressure.

The main physical reason for the occurrence of the compression shock is the following: Let us first assume a purely subsonic flow through a converging-diverging nozzle. If we raise the outlet pressure by a small amount, the pressure change propagates upstream with a velocity which is equal to the velocity of sound minus the velocity of flow. The end effect is an adjustment of the pressures and velocities in every cross section to the new pressure ratio. However, if the velocity at the outlet is supersonic, a small pressure rise is unable to travel upstream, since the velocity of the gas is larger than the velocity of pressure propa-

gation. Consequently, the effect of pressure change that is imposed on the periphery of the jet is confined to the downstream portion of the jet, more exactly to the region downstream from a conical surface emanating from the cross section of the orifice. In this case we obtain an oblique shock outside the nozzle. Now it can be shown that a finite pressure rise travels with a higher velocity than the velocity of sound which is, strictly speaking, the velocity of propagation of an infinitesimal pressure change. Consequently, a large pressure rise applied to the outlet is able to intrude upstream into the nozzle. By doing so its intensity and its velocity of propagation decreases until it becomes equal to the velocity of the stream. Thus we obtain a stationary compression shock at some cross section inside the nozzle.

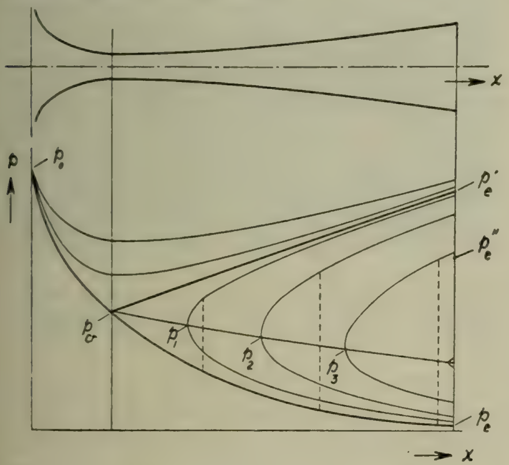


Fig. 2.—Computed pressure distributions in a converging-diverging nozzle for various exit pressures.

Fig. 2 shows computed pressure distributions along the axis of a nozzle for various exit pressures p_e. The limiting value for which subsonic flow occurs is denoted by p_e'. The exit pressure which produces supersonic flow without shock is p_e. The curves ending at values between p_e and p_e' denoted by p_e'' refer to adiabatic change of state after a shock occurred. The curve $p_{cr}p_1p_2p_3$ refers to states in which the velocity is equal to the local velocity of sound. If the exit pressure is above the end point of this curve, the shock is inside of the nozzle and the flow beyond the shock is subsonic. If the end pressure is lower the flow is supersonic along the whole nozzle and the applied shock occurs downstream outside of the nozzle.

We can produce compression shock by performing another fundamental experiment, namely, putting an obstacle, for example, an inclined plane or a wedge in the way of the gas moving with supersonic velocity (Fig. 3). If we perform this experi-

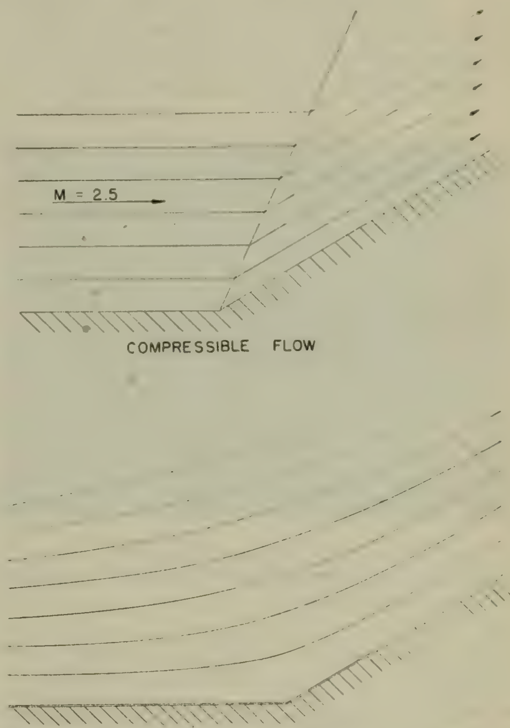


Fig. 3.—Compressible and incompressible flow against an inclined surface.

ment in a subsonic stream, we obtain the stagnation pressure at the corner and the flow is deflected smoothly to follow the new direction. In the case of supersonic flow the pressure rise caused by the obstacle is unable to propagate indefinitely in the upstream direction. If the angle of deflection is small, we obtain a compression shock starting out from the corner. If the angle of deflection is larger, the pressure rise will travel to a certain distance up stream and we obtain a stationary compression shock at a certain distance up-

stream from the corner.[3] Between the compression shock and the wedge in this case the flow is subsonic. These fundamental observations are helpful in the understanding of the phenomena connected with the problem of a body moving in a fluid at rest which we shall consider more conveniently as the problem of flow in an infinitely extended fluid around a solid body.

Considerable experimental material is available about the drag of bodies moving with supersonic velocity from ballistic experiments, essentially from firing tests. Let us consider a body of revolution at rest and assume that the gas is moving with supersonic velocity relative to this body parallel to its axis. We obviously have a case which is analogous to that mentioned at the end of the last section. For example, if the body of revolution has a sharp nose, the fluid moving with supersonic flow is forced to be deflected in the direction of the tangential plane of the ogive. If the angle of deflection is small (Fig. 4), we obtain a compression shock starting from the vertex. If the angle of deflection is large (Fig. 5), we obtain a compression shock in the free air upstream from the body. Such a shock is called a detached shock.

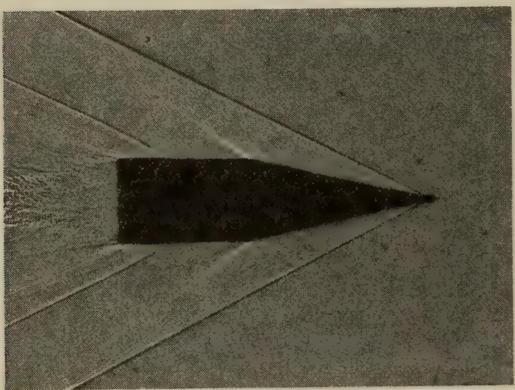


Fig. 4.—Attached shock wave at a conical ogive of small vertex angle. Mach number = 2.481, semivertex angle = 12.1°.

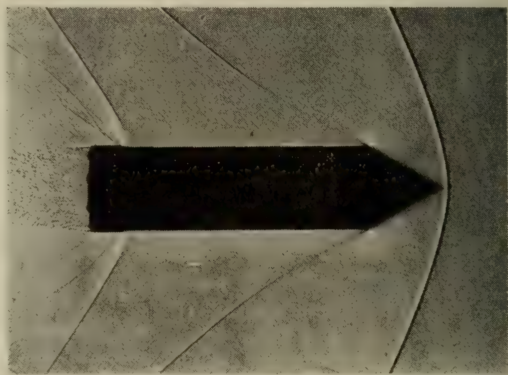


Fig. 5.—Detached shock wave at a conical ogive of large vertex angle. Mach number = 1.25, semivertex angle = 30°.

Let us consider the influence of a compression shock on the drag. In the purely subsonic case the drag of a body consists of two parts; the frictional drag and the form drag. The frictional drag is an unavoidable item in any real, i.e., viscous fluid. The form drag can be avoided if we prevent separation, or as we sometimes say, vortex shedding from the body. As a matter of fact, a streamlined body in an ideal incompressible fluid has no drag at all, as was recognized very early by d'Alembert. To be sure, we obtain a pressure rise at the nose equal to the stagnation pressure. However, this pressure rise is balanced by suction at the front part and by pressure at the rear part of the body. In the case of the so-called "half body," i.e., a body with a "nose" and a cylindrical portion extending to infinity, the pressure at the nose and the suction at the shoulder of the body are balanced in a way that the resultant force is zero. The same statement is true for an ideal compressible fluid provided the flow is subsonic everywhere. In the case of the supersonic flow the pressure at the nose is in general smaller than the stagnation pressure, but owing to the compression shock no suction of the shoulder occurs or at least it is reduced to such extent that a considerable form drag results. Fig. 6 shows computed pressure distributions on the nose part of a half body for incompressible flow and for supersonic flows at various Mach numbers. Fig. 7 shows experimental drag curves for a shell with sharp nose, and for several shells with blunt noses,

[3] Strictly speaking, if the "deflector plate" is extended to infinity, the compression wave would travel upstream to infinity; if the length of the deflector is finite, the above statement is correct.

including a sphere. A shell or a sphere has considerable form drag also at low Mach numbers, due essentially to the wake produced by lack of streamlining of the rear end of the body. However, the drag increases rapidly as the velocity of the shell passes through the velocity of sound of the medium. It is seen that this increase starts at a Mach number substantially smaller than unity and the shape of the curve in this transition range which we denoted by the term "transsonic" apparently greatly depends on the form of the nose. The following section deals with this range.

Instead of a shell we shall consider a cylindrical body such as an airplane wing of long span moving through the air at rest. Let the velocity of motion be smaller than the velocity of sound. To an observer moving with the wing the fluid appears to approach the wing with a certain subsonic velocity and is accelerated along the curved boundaries of the wing. Let us assume for the sake of simplicity that the air is not extended indefinitely but is limited by two surfaces parallel to the direction of motion of the wing and at a certain distance from the wing. Obviously both the upper and the lower parts of the flow are analogous to a flow in convergent-divergent nozzles. We have a throat at the upper surface of the wing and a throat at the lower surface.

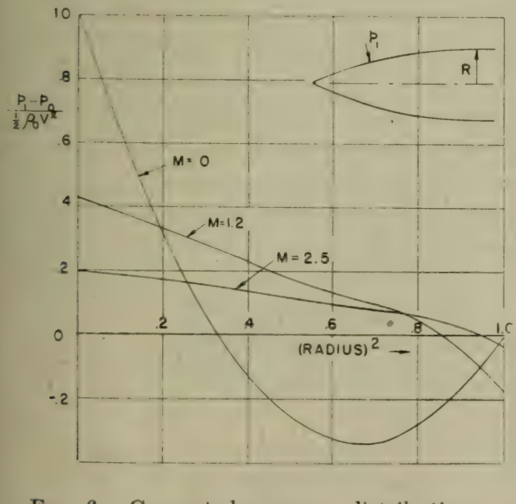


FIG. 6.—Computed pressure distributions on the nose of a half body for incompressible flow ($M=0$) and for supersonic flows at various Mach numbers.

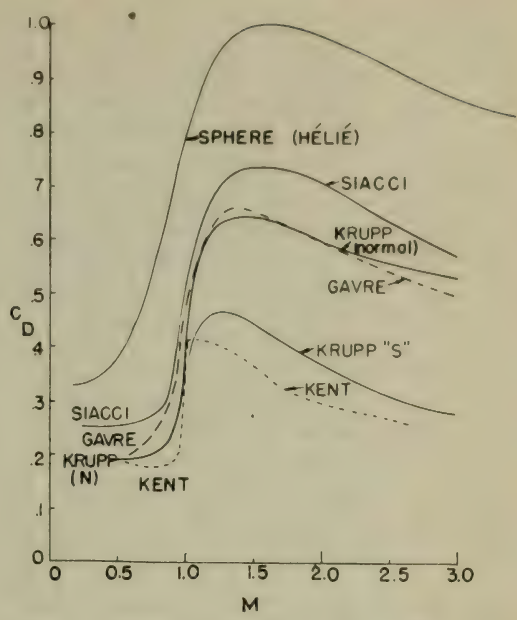


FIG. 7.—Experimental drag curves for a shell with sharp nose (Kent), for several shells with blunt nose, and for a sphere.

Consequently, the velocity of sound may be reached in the throat before the body itself moves with sonic velocity. The flight velocity at which the local velocity reaches the local velocity of sound is sometimes called the "lower critical velocity of the wing." Now in reality the air is not restricted by a solid surface; however, the outer part of the air exerts a certain resistance against deflection by its inertia and the result of this resistance is essentially similar to the effect of a solid surface. Therefore, in the airflow adjoining the airplane surface similar phenomena will occur as are observed in nozzles. We have seen that the flow in the nozzle is characterized by two facts: first, if the velocity of sound is reached in the throat the amount of fluid flowing through the nozzle cannot be increased further. Second, if the downstream pressure is higher than corresponds to the expansion ratio of the nozzle, a compression shock results. Both phenomena can be observed in the case of the wing. The first one causes a substantial decrease of the lifting capacity of the wing; the second one increases its drag.

The amount of lift produced by an airplane wing, is, generally speaking, determined by the difference of pressure between

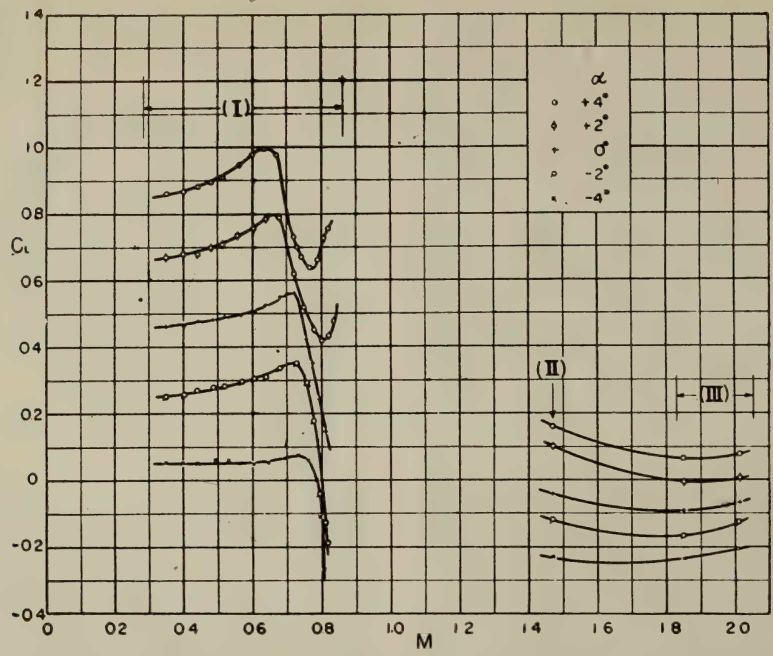


FIG. 8.—Lift coefficients of airfoils as a function of Mach number M and angle of attack α.

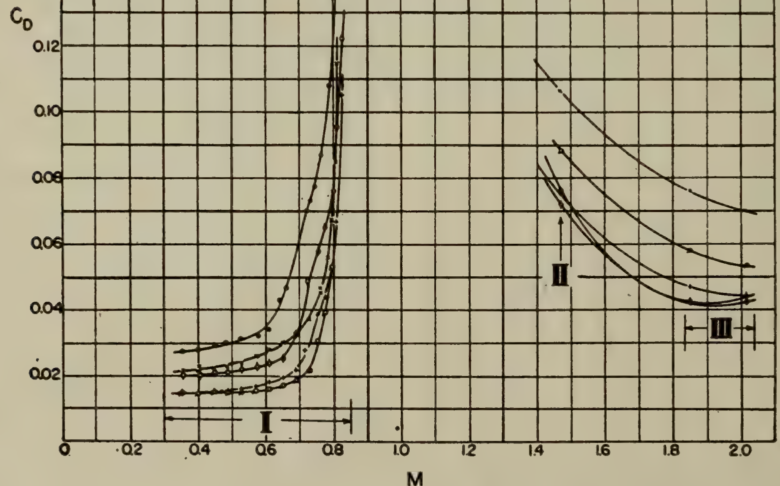


FIG. 9.—Drag coefficients of airfoils as a function of Mach number M and angle of attack α.

the lower and the upper surface. For example, in the case of a cambered wing the air is accelerated along the upper surface to a greater extent than at the lower surface, and therefore at the upper surface a larger suction will be produced than at the lower surface. The difference of the resulting suctions furnishes the lift of the wing. Now it is evident that because of the larger camber of the upper surface the velocity of sound will be reached sooner in the upper than in the lower surface. In other words, what we can call the throat condition will occur earlier at the upper surface. Consequently, even if we further increase the flight velocity of the wing the magnitude of the suction at the upper surface will cease to increase. The lift practically becomes independent of the velocity of flight, whereas in subsonic conditions the lift of an airplane wing increases with the square of the velocity. We call the ratio between the lift per unit area and the dynamic pressure of the corresponding flight velocity, the lift coefficient. Hence, if the lift remains constant with increasing flight velocity, the lift coefficient must rapidly decrease. Fig. 8 shows lift coefficients of airfoil sections as functions of Mach number as measured in wind tunnel. No reliable data exist for the transsonic range between $M = 0.85$ and $M = 1.4$.

We can express the same phenomenon in another way. The lift produced by a wing is the result of the deflection of the air passing along the chord. As a matter of fact, the lifting force is the reaction of the air pushed downward in unit time. The main part of the lift is produced by the deflection of the air passing near to the lifting surface. The contribution of the outer parts is relatively small. Now if we have a throat condition, the amount of air passing in a given neighborhood of the wing surface ceases to increase with increasing flight velocity and therefore the lift will not increase at the same rate with the flight velocity as it did before.

The appearance of shock waves at flight velocities approaching the velocity of sound was observed both in flight and wind tunnel. It is the primary cause of the "premature increase" of the drag, i.e., the increase that occurs before the flight velocity reaches the velocity of sound. Fig. 9 gives measured values of the drag coefficient of airfoils as functions of Mach number. It was found that the mere presence of supersonic velocity in a certain region does not necessarily involve the occurrence of compression shocks. The flight velocity at which the compression shock first appears is called the "upper critical flight velocity." Its determination, i.e., the exact conditions for the first appearance of shock waves are the subject of extensive theoretical and experimental research work. However, most of the scientific investigations in this field can become common knowledge only after the war because of the close connection between such purely scientific problems and the design problems of airplanes able to fly at transsonic velocities.

Fig. 10 shows so-called "Schlieren" pictures of the flow over a curved surface simulating the conditions on the upper surface of an airfoil. Flow direction is from right to left. Black means expansion in flow direction, the white lines indicate sudden increase of density. Fig. 10*a* is taken at a low Mach number, 10*b* at $M = 0.65$, 10*c* at $M = 0.75$, 10*d* at $M = 0.83$. The photographs also show that simultaneously with the occurrence of the shock wave the flow separates from the wing surface. This separation is the principal cause for the drag increase.

Obviously, it is an intriguing question whether there are any intrinsic limits for flight velocity. Many people will ask "Shall we ever fly faster than sound?" I do not believe that at the present time this question can be answered by a straight "yes" or "no." There is one case that can be treated in a rather simple way: the case of an airplane diving vertically. You may remember we have read several times in the news that one or another pilot claimed that he had reached while diving a speed faster than sound velocity. In the stationary state of vertical diving the weight of a falling body or a diving airplane is equal to the drag. As mentioned before, we usually express the drag D of the airplane by the product of the drag coefficient, C_D the wing area S, and the half product of the

density ρ and the square of the velocity v. Introducing the value of the velocity of sound by the formula $c^2 = \gamma p/\rho$, this equation can be expressed also in the following form:

$$D = \frac{\gamma}{2} C_D S p M^2 \qquad (5)$$

i.e., the drag equals the product of the wing area, the atmospheric pressure at the altitude at which the diving is performed, the square of the Mach number multiplied with a numerical factor equal to $\gamma C_D/2$. Using the value $\gamma = 1.405$ and putting the drag equal to the weight W of the airplane, we obtain the following expression for the value of the drag coefficient which permits a certain Mach number M to be reached in diving:

$$C_D = 1.42 \frac{W}{Sp} \frac{1}{M^2} \cdot \qquad (6)$$

For diving at sound velocity, we have to substitute $M = 1$ in this equation. The weight of the airplane divided by the wing area is called the wing loading l_w. Hence, we obtain for the maximum value of the drag coefficient which would permit diving at sound velocity the following simple expression:

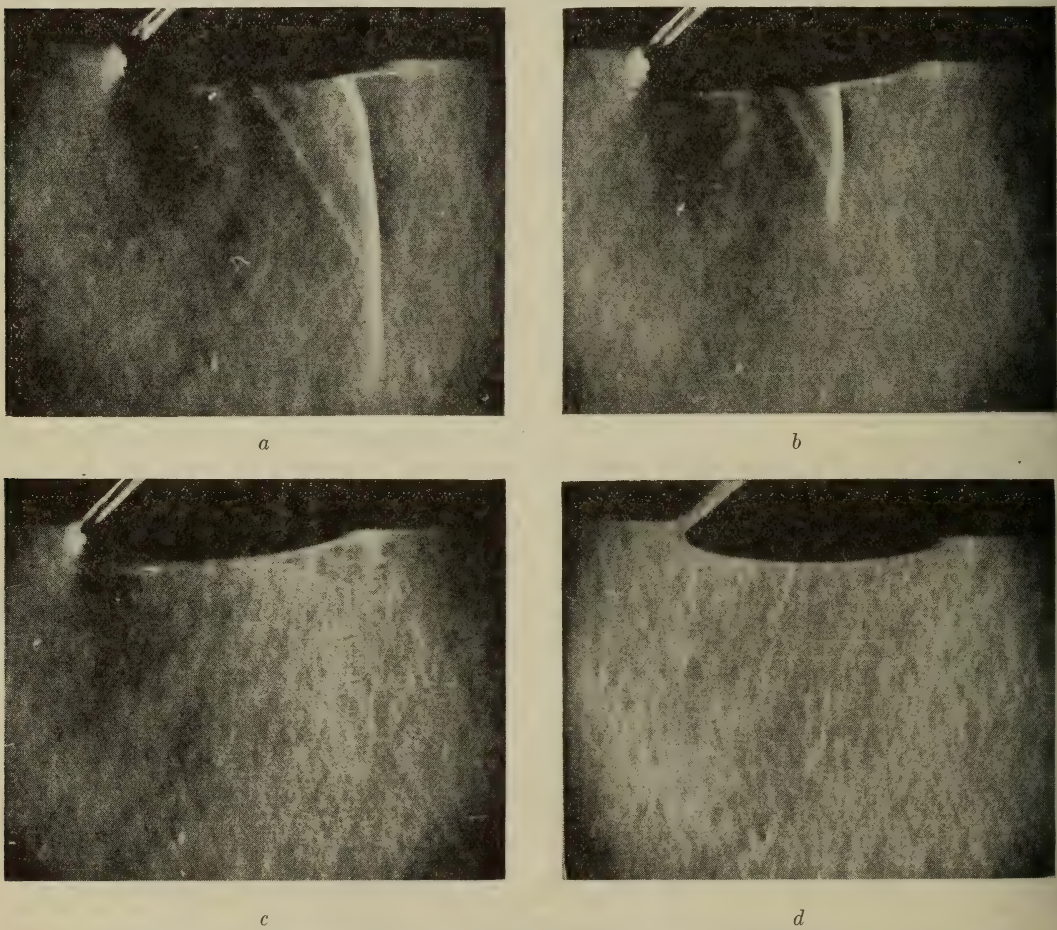


FIG. 10.—Schlieren photographs of flow past an elliptical cylinder with 0.15 thickness ratio at zero angle of attack. The direction of flow is from right to left. The small oblique channel visible in the pictures at the leading edge of the ellipse serves to remove the upstream wall boundary layer. Correct flow past the surface of an elliptical cylinder is thus obtained using only *half* of an elliptical section. Dark areas correspond to expansion, light areas to compression. Exposure time 1/25 sec.

$$C_D = 1.42 \frac{l_w}{p} \cdot \qquad (7)$$

Table 2 gives the values of the allowable maximum drag coefficient as function of altitude and wing loading. The wing loading of fast modern airplanes is of the order of 35 to 50 pounds per square feet; unmanned missiles have still higher wing loading. On the other hand, the drag coefficient at low speeds, i.e., low Mach numbers is reported to be about 0.02 for the Spitfire and about 20–25 per cent lower for some fast American fighters. It is seen that the question as to whether such an airplane can dive with sound velocity depends on the ratio between the drag coefficient at $M = 1$ and at low Mach numbers, say $M \rightarrow 0$. There is no exact information available about this ratio. However, if we use ballistic data for estimating the ratio, it appears that we have a marginal case. It should not be impossible to make design alterations that would allow an airplane of the present general type to dive at a speed equal to the velocity of sound.

Table 2

Altitude (ft.)	Pressure (lb./ft.²)	Wing loading (lb./ft.²)			
		30	40	60	80
Sea level....	2,106	0.0202	0.0269	0.0404	0.0538
10,000......	1,448	0.0294	0.0392	0.0588	0.0784
20,000......	968	0.0440	0.0586	0.0880	0.1172
30,000......	626	0.0680	0.0906	0.1360	0.1812
40,000......	390	0.1092	0.1456	0.2184	0.2912

The case of level flight at transsonic and supersonic speeds is much more complex. The present official international world record is 468.94 m.p.h. (1939). To be sure, according to regulations the flight for the international speed record has to be performed at sea level. We do not know what maximum speed was reached actually in recent years. Probably the man who will first challenge the world record will have to prepare himself for a substantial step up. The problem is complex because reduction of the drag of the airplane is only less than half of the whole story. The question of weight is the most important point. First, of course, a certain percentage of the total weight is necessary for safe structure. Then the airplane has to carry the weight of the power plant and the weight of the fuel. The size of the power plant is determined by the thrust required to balance the drag, the weight of the fuel by the thrust required and the desired flight duration.

In general, the power plants of lighter weight for the same power output consume relatively more fuel. The power plants of high fuel economy are relatively heavier. The aerodynamic considerations give preference to high altitude; on the other hand, a power plant of a given weight will furnish, in general, less power at a higher altitude.

To some extent the question of supersonic flight is analogous to another intriguing problem discussed sometimes by serious men, more often by authors having more imagination than scientific knowledge. I mean the question of the feasibility of navigation off from the gravitational field of the earth. Of course, some fabulous new fuel would change the situation completely in both cases. However, basing the consideration on power plants and fuels which are available or which we hope to have with reasonable expectation, the answer to the question of the feasibility of stellar navigation is probably negative, whereas there is no evidence that the velocity of sound should constitute a "stone wall" of despair. To be sure, it will be necessary to use all good advice which aerodynamic science, chemistry of combustion, and thermodynamics may contribute.

We did not touch one question at all, a question that perhaps is fundamental: Why does anyone want to travel so fast? I think this question is too difficult for an engineer. It should be asked of a philosopher.

GEOCHEMISTRY.—*Contact deposits in an artificial silicate magma.*[1] HERBERT INSLEY, Pennsylvania State College.

It is my purpose here to give an example of how petrological laboratory methods may be applied to a technological problem and how in turn the solution of that problem affords some speculation on a question in petrogenesis. Much of the work referred to was done some years ago, but interest in it and in the petrogenetic speculations arising from it has lately been renewed because of war work on the corrosion of optical glass melting pots.

The technological problem in question was the determination of the cause of the corrosion and failure of refractories used in glass melting, and, therefore, a necessary part of the solution was the determination of the course of attack and the reaction products produced by the attack of molten glass on the walls of the tank used as container. The method used was the petrographic-microscopic examination of the contact zones of glass and container.

The molten glass in a melting tank is an artificial silicate magma and in general is not unlike a natural magma, although there are some marked differences in detail. The artificial and the natural are similar in that both are silicates, and the containing chambers of both are composed of similar materials. They differ in the details of their composition, the temperatures to which they are exposed, the time of exposure, the amount and character of the gaseous phase present, and the rate of flow of the magma in the basin.

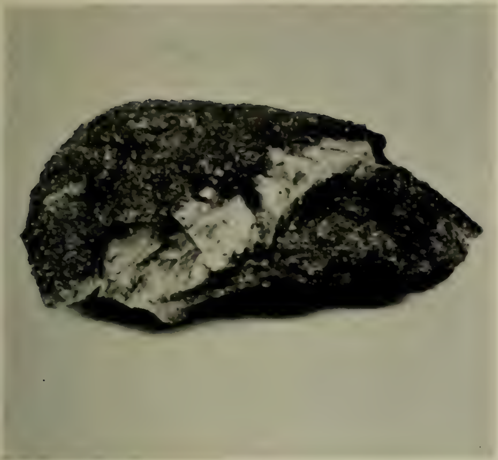
The glass-containing portions of tanks are generally rectangular in plan and in elevation, varying in dimensions from one 25 feet long by 12 feet wide by 2 feet deep to one as large as 100 by 60 by 3 feet. The quantity of glass contained may range from 60 to 1,500 tons. The walls and floor of the tank which are in contact with the molten glass are essentially an aluminum silicate. Sometimes they are fired clay blocks and sometimes a mixture of alumina and silica fused and cast into blocks. The alumina-silica ratio of such refractories may vary over a wide range. The roof and upper side walls in contact with the tank atmosphere are generally made of silica brick with a silica content of more than 95 percent. The melting end of the tank is separated from the "refining" end by a refractory wall (the "bridge wall"), the molten glass passing from one section to the other by means of a submerged "throat."

The batch mixture consisting usually of alkali carbonate or sulphate, limestone, and quartz sand with the occasional addition of other substances is introduced into the melting end of the tank and melted by the radiant gases from burning producer gas, fuel oil, or natural gas passing over the surface of the tank. Melting temperatures of 1,450 to 1,500° are generally used. The reaction to form glass proceeds by the removal of carbon dioxide and the mutual solution of the alkalies, lime, and silica. Magnesia is sometimes substituted for part of the lime and additions or substitutions of other oxides such as alumina, lead oxide, barium oxide, etc., are frequently made. In the usual commercial window or bottle glass silica may range from 68 to 74 percent, soda from 11 to 17 percent, and lime from 8 to 14 percent. By comparison, the igneous rocks all contain much more alumina. Only the granite group contains as much silica and only the nephelite rocks as much alkali.

Unlike natural igneous rocks where complete vitrification is extremely rare the chief aim in the manufacture of commercial glass is the total elimination of crystalline material. Within the glass-melting tank itself some crystallization may take place in corners where circulation is poor or an accumulation of unmelted batch material and devitrified glass may be gathered behind the bridge, but the appearance of these materials in the finished glass will cause the rejection of the ware.

The reactions of the molten glass with

[1] Address by the retiring president of the Geological Society of Washington, delivered at the 51st annual meeting of the Society, December 8, 1943. Received February 5, 1945.



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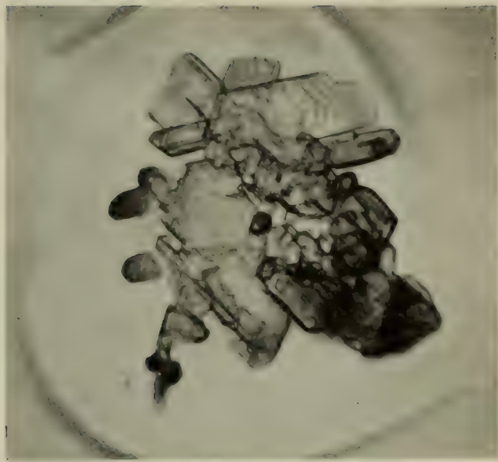

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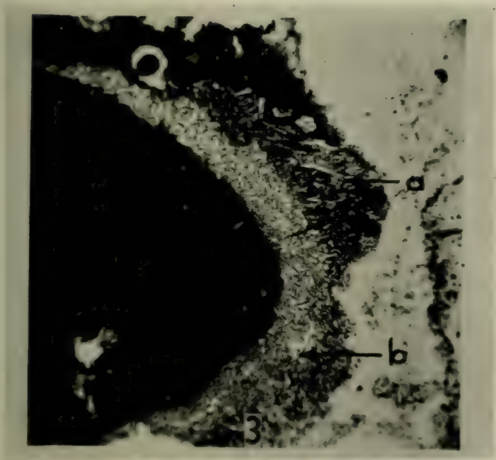

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4

FIG. 1.—Broken piece of clay refractory block after exposure to the atmosphere of the glass tank above the glass level showing dark crust of small crystals of corundum on outer surface (left) with bleached layer of vitrified refractory next and unattacked refractory below. About $\frac{1}{3}$ natural size. FIG. 2.—Aggregate in glass of platy crystals of corundum in parallel arrangement probably originating in the crust on aluminum silicate refractory above the glass level and carried down into the glass with liquid silicate material. ×16. FIG. 3.—A "stone" of aluminum silicate refractory embedded in glass with an outer reaction rim of skeleton nephelite (marked "a") and an intermediate zone of thin platy crystals of corundum (appearing as needles in area marked "b"). ×50. FIG. 4.—A "stone" embedded in glass that was originally aluminum silicate refractory but that has been completely converted to nephelite by reaction with the glass. An outer zone of skeleton crystals with a core of complete nephelite crystals. ×40.

the walls of the container are interesting not only from the point of view of the glass manufacturer, who is concerned with the durability of the glass tank and the purity of the glass produced, but also from the point of view of the petrologist and the silicate chemist. The corrosion of the tank walls weakens the container by loss of materials and also introduces crystalline reaction products and undissolved wall material into the glass.

That part of the aluminum silicate refractory above the level of the molten glass is subject to reaction with the tank atmosphere. This atmosphere contains the unburned fuel gases and the products of combustion as well as volatilized alkalies and the batch dusts composed largely of alkali carbonates with smaller amounts of the coarser-grained quartz and limestone. Usually the ratio of alkalies to lime and silica is much higher in the tank atmosphere than in the molten glass. The action on the aluminum silicate refractory above the glass level is in general a decomposition to form crystalline alumina (αAl_2O_3 or corundum) in a liquid sodium calcium aluminum silicate. On vertical or sloping side walls the platy crystals of corundum tend to form a network from which the silicate liquid drains away into the glass in the tank often leaving a thick crust of corundum crystals (Fig. 1). At times the corundum crystals are carried into the tank glass with the liquid silicate to form troublesome and relatively insoluble "stones." Where the liquid is retained on the refractory wall it may sometimes crystallize to a plagioclase feldspar[2] or, more rarely, to nephelite ($NaAlSiO_4$).

The reaction to form corundum and liquid (Fig. 2) in the aluminum silicate refractories exposed to the glass furnace atmosphere at operating temperatures takes place even though the refractory block has a composition more highly siliceous than that of a pure dehyrated kaolinite (Al_2O_3—46 percent, SiO_2—54 percent) where one might reasonably expect an aluminum silicate such as mullite to form. A consideration of the solubility relations in the system, $Na_2O-Al_2O_3-SiO_2$ (Fig. 5[3]) at these temperatures shows the reason for the phases present. The boundary of the primary phase fields of mullite ($3Al_2O_3 \cdot 2SiO_2$) and corundum (Al_2O_3), which in the $Al_2O_3-SiO_2$ system lies at a SiO_2/Al_2O_3 ratio, is 78/22 and the Na_2O percentage is about 10. This represents a deep salient of the corundum primary phase field into the ternary system and in effect means that at the operating temperatures of glass tanks corundum may be the product of reaction between aluminum silicate and soda where the original blocks were considerably higher in silica than kaolinite and which, therefore, may have contained originally considerable quartz. Moreover, close to the quintuple point albite-mullite-corundum-liquid-vapor the isotherms (not shown on the diagram reproduced) indicate that corundum may be a product of crystallization from the liquid at temperatures as low as 1,100°, although there is a very sharp increase in liquidus temperatures toward the Al_2O_3 apex of the diagram. The diagram of the $K_2O-Al_2O_3-SiO_2$ system[4] indicates the same strong inclination of the corundum-mullite boundary toward the silica apex as in the $Na_2O-Al_2O_3-SiO_2$ system. In the $CaO-Al_2O_3-SiO_2$ system[5] the inclination of the mullite-corundum boundary is also toward the SiO_2 apex, although it is not nearly as pronounced as in the other two diagrams.

Approximately the same reaction products are formed at the contact of molten glass and aluminum silicate refractory as are formed above the level of the molten glass, although the relative quantities are

[2] Feldspar crystals of the composition of oligoclase and labradorite have been observed.

[3] The figure shown is reproduced by the kind permission of J. F. Schairer, of the Geophysical Laboratory, and represents his tentative and as yet unpublished data on this system. Although later work may change some details of the diagram, he does not believe that any changes of significance to this discussion will be made in the final form.

[4] Reproduced in N. L. BOWEN's *Petrology and silicate technology*, Journ. Amer. Cer. Soc. **26**: 285–301. 1943.

[5] As modified from RANKIN and WRIGHT, Amer. Journ. Sci. **39**: 1–79. 1915; BOWEN and GREIG, Journ. Amer. Cer. Soc. **7**: 238. 1924; and GREIG, Amer. Journ. Sci. **13**: 35–41. 1927; and summarized in HALL and INSLEY, Journ. Amer. Cer. Soc. **16**: 524. 1933.

much different largely because of the fact that considerably greater percentages of silica and lime take part in the reaction in the former case than in the latter. In the reaction between glass and refractory, moreover, both of the reaction products, corundum and liquid, are carried away from the reaction face, thus continually exposing new material to attack. In fact, both above and below the glass line the reaction is a non-equilibrium process even over very short distances. Mullite and glass are the products produced in the manufacture of the refractory. In refractories below the glass level the first evidence of the reaction of the molten glass is shown by an increase in the amount of glass with respect to that of mullite with the eventual appearance of tabular rhombohedral crystals of corundum. The outer portion of the corundum layer (next to the glass) frequently contains skeleton crystals of nephelite (Fig. 3), sometimes associated with carnegieite. In the melting end of the tank the temperatures are generally far too high to permit the formation of the nephelite-carnegieite phase, and here the crystallization probably takes place during the cooling of the tank after a campaign. In the cooler portions of the tank operating temperatures are frequently within the range in which these compounds may crystallize. Below the glass level, as well as above, corundum crystals may form as a reaction product on refractories in which the Al_2O_3/SiO_2 ratio is considerably below that of kaolinite (46/54). Even a refractory material that contains enough excess silica for considerable free quartz may

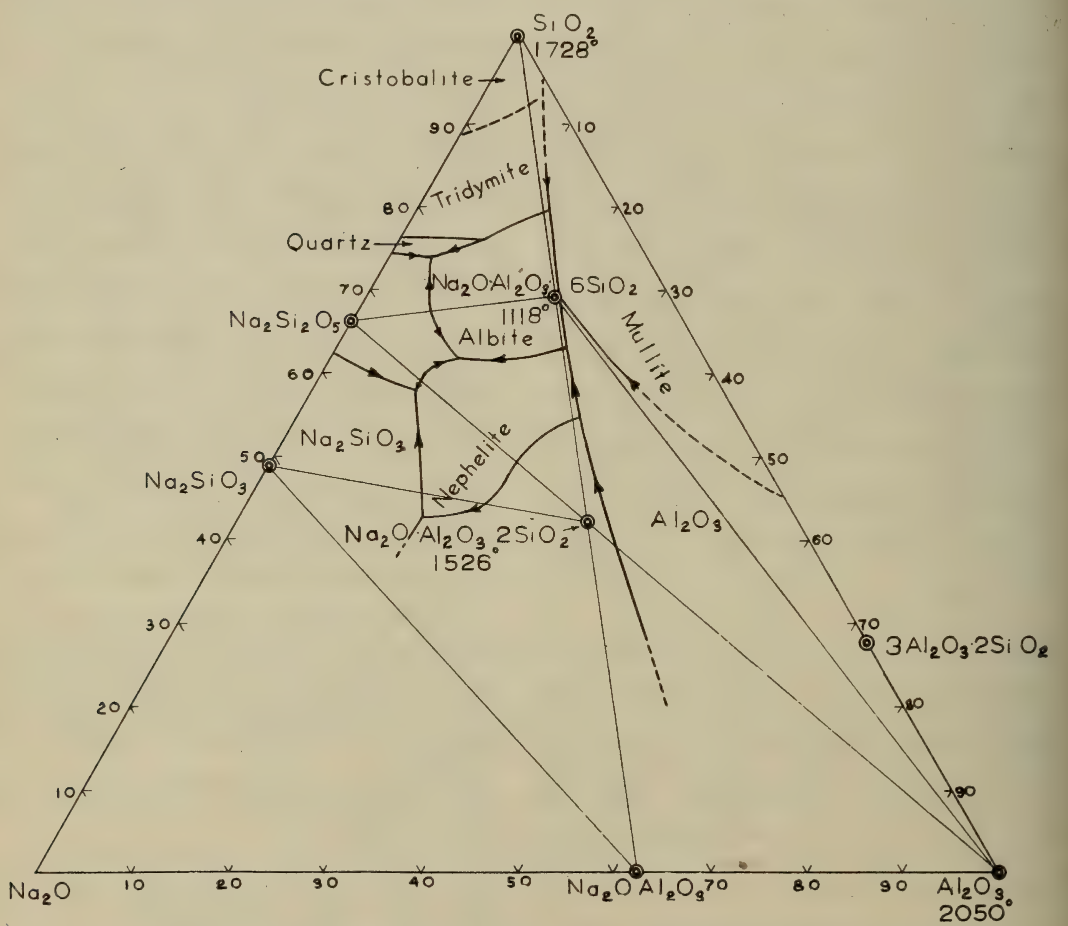

FIG. 5.—Preliminary diagram by J. F. Schairer of the phase relationship in the system Na_2O–Al_2O_3–SiO_2. Reproduced with permission from unpublished data.

produce corundum with the molten glass. In xenoliths of refractory material which have been carried away in the magma varying degrees of metamorphism and digestion have been observed. Pieces that have broken from the refractory near the exit end of the tank and presumably exposed to reaction at fairly low temperatures (very approximately 1,100°C.) for a short time may have slight evidences of solution of the mullite crystals with a few extremely thin corundum crystals at the contact. In others which have undergone longer attack at higher temperatures the mullite crystals have disappeared completely, and the inclusion has a core composed of a mass of small corundum crystals in a matrix of nephelite with an outer zone composed of almost pure nephelite. Where reaction has gone still further, the corundum crystals have disappeared completely, and nephelite is the only crystalline material remaining (Fig. 4). "Stones" showing all these stages of reaction have been gathered from a glass melting tank which has been closed down for repairs of the badly corroded refractories after a long melting period.

A partial substitution of potash for soda, as is the case in some commercial and in some optical glasses, produces the same general reaction products with the refractories. The feldspathoid associated with corundum is in this case a nephelite-kaliophilite solid solution. In lead-containing optical glasses corundum also is a product of the reaction between molten glass and refractory even in the absence of alkalies.

The solution of the technological problem of increasing the resistance of the refractory to corrosion by molten glass would appear to be simple from the purely chemical point of view after the products of the reaction have been identified. A moderate increase in the alumina content of the refractories may, however, do more harm than good, because solution of the more soluble phase in the molten glass may release abundant, relatively insoluble corundum crystals into the glass and cause the rejection of the ware because of "stones." If the refractory can be made out of homogeneous, nonporous, pure alumina, then whatever slight solution there is will be uniform and do little or no damage to the glass. Technical difficulties in the manufacture of a mechanically stable refractory of this type are numerous, however, and so far it has not been satisfactorily solved.

The fact of the occurrence of corundum as a contact metamorphic deposit in an artificial igneous magma at once brings up the question of its pertinence to the origin of corundum deposits in nature. It is notable that practically all deposits whose geological relationships are at all clear are in, or are closely associated with, igneous bodies and that, with one notable exception, these deposits occur sharply localized at the contact with the country rock or in association with partly digested xenoliths. The exception is the group of Ontario corundum bodies.

The deposit in nature that most nearly approximates that in the glass tank with respect to the composition of the intrusive magma and the absence of pneumatolytic or hydrothermal effects is undoubtedly that at Nun's Pass in the Island of Mull described by H. H. Thomas.[6] Here the central felsitic portion of the invading magma in the sill has a composition of about 71 percent SiO_2, 12 Al_2O_3, 3.5 FeO, 1.3 CaO, 4.7 K_2O, and 2.5 Na_2O, which is not greatly different from that of commercial glass. The invading rock lining the walls is of a somewhat different character. On one wall it is characterized by cognate, on the other by accidental xenoliths. The accidental xenoliths are the important ones in this connection. In part they are buchites containing mullite and cordierite in glass astonishingly similar in texture to the matted mullite needles in the glass tank refractory in the first stages of attack by the molten glass. The most abundant accidental xenoliths, however, are those containing assemblages of corundum, spinel, anorthite, and a small amount of interstitial glass with the anorthite often acting as a matrix for the corundum and spinel. Even the rock acting as host for the xenoliths is so contaminated by introduced material that Thomas does not consider it as a truly igneous rock. The xenoliths are thought by Thomas to be formed by the direct fusion

[6] Quart. Journ. Geol. Soc. **78**: 229. 1922.

of highly aluminous sediments in the magma, although the effect of the alkalies would be to lower markedly the SiO_2/Al_2O_3 ratio at which corundum could form.

There are other corundum occurrences that provide a somewhat less perfect analogy to the glass-melting tank. In the Eifel district in Germany hornblende andesites contain included fragments or streaks composed of cordierite, sillimanite, feldspar, corundum, etc., which are considered to be crystalline schists that have been partly digested and recrystallized. In the Herz Mountains a biotite-plagioclase dike intrusive into clay slates contains cordierite, garnet, cyanite, sillimanite, and corundum, which are not characteristic of any purely igneous rock. A number of other occurrences can be cited where rocks varying from granites to andesites, diorites, and nepheline syenites are closely associated with, or evidently intrusive into, clay-bearing rocks with corundum in the intruded rock, the intrusive rock, or both. The chemical and phase relationship pointed out in the systems Na_2O–Al_2O_3–SiO_2 and CaO–Al_2O_3–SiO_2 seem adequate to explain the origin of corundum in these cases. Whether the formation of corundum is the result of contact metamorphism and recrystallization with the intervention of very little liquid phase, or whether the clay-bearing rocks have been partially digested in the igneous solution and then recrystallized, appears to be of no fundamental importance. The point is that localized reaction has taken place with rocks that, although, of course, aluminous, need not have any higher Al_2O_3/SiO_2 ratio than ordinary clay, i.e., $Al_2O_3/2SiO_2$ molecularly. The presence of aqueous solutions at high temperatures and pressures need cause only a lowering in the temperature at which the reactions take place, and the solubility relations expressed by the bending of the mullite-corundum boundary toward the silica apex which exist in the anhydrous system may also exist in the presence of water.

The contact relations in some other deposits of corundum associated with alkaline rocks cannot be so clearly visualized nor the crystallization so definitely connected with phase relations in the alkali-alumina-silica systems. In the Ontario deposits where corundum bodies are developed in syenites, nepheline syenites, and anorthosites Barlow[7] postulated that corundum crystallized directly from a high alumina magma and based his deduction on the relationships found by Morozewicz[8] in some empirical laboratory experiments on artificial melts. No one has so far, however, proposed any hypothetical line of petrologic descent from any of the conventional parent magmas that would result in the crystallization of free alumina and its concentration by any process of magmatic differentiation. Barlow, himself, emphasizes the fact that the Ontario corundum deposits, although relatively large, are extremely localized and that the host rocks are chiefly notable for extreme and rapid variation in composition and mineral assemblages. These are not characteristics of crystallization from an originally homogeneous magma even with later crystal sorting. May not the Ontario deposits represent a later stage in a process like that which operated in the Nun's Pass rocks? Although no source of the aluminous sediments was found in the latter case, the relationships in the final rock were such that this genesis could not be doubted. In the Ontario rocks the source of the sediments may have been further removed and the progress toward homogeneity somewhat more advanced.

The case of the association of corundum deposits with basic rocks like the peridotites and norites is more difficult to explain. Additions of neither magnesium metasilicate nor magnesium orthosilicate to alumino silicates of the composition of the quadruple point (approximately $54Al_2O_3$, $46SiO_2$) bring the mixtures within the regions where corundum is either a final or intermediate product of crystallization. The presence of ferrous oxide in the olivines or of alkalies in the alumino silicates may alter the relations sufficiently to permit

[7] A. E. Barlow, Canada Dept. Mines. Geol. Survey, Memoir 57. 1915.

[8] J. Morozewicz, Tschermak's Pet. Mitt. **18**: 1–90. 105–240. 1898.

corundum to crystallize. It has also been pointed out in the case of the corundum deposits occurring with dunite in North Carolina that the mineral associates of the corundum are those characteristic of hydrothermal metamorphism.[9] It may be that water at elevated temperatures and pressures can also reverse the trend of the mullite-corundum boundary in systems with magnesia. A few preliminary high-temperature experiments with additions of ferrous oxide, water, or both should demonstrate whether the production of corundum is possible under these simplified composition relationships. The rather constant association of granitic gneiss or clay schist country rock with the corundum that is formed at the borders of basic magnesian rocks can hardly be accidental, and the source of the corundum would logically appear to be the reaction of the intruding and intruded rocks whether or not water vapors or other "mineralizers" take part in this reaction.

These remarks can be summarized briefly. It has been shown that corundum is formed in a glass-melting furnace by the action of a melt containing large amounts of silica and alkalies and considerable lime on an aluminum silicate wall material that approximates dehydrated kaolin in composition and that the formation of corundum under these conditions is explained by the phase relationships in the system Na_2O–Al_2O_3–SiO_2. It is pointed out that the origin of corundum at the contact of syenites and nepheline syenites with aluminum silicate country rocks may be similar and that whether the corundum forms by localized digestion and crystallization from solution or by reaction essentially between the solids is a difference in degree and not in kind. Moreover, the country rocks do not have to be abnormally high in alumina, since in the case of glass tanks, at least, alumina-silica ratios lower than that of kaolin are sufficient to produce corundum by reaction. In the case of the reaction of highly basic magnesian magmas (peridotites and the like) with wall rock the reaction relations are less easy to understand. Nevertheless, the reaction relations must not differ radically from those found in the case of alkaline magmas even though water becomes a necessary agent in the reaction.

[9] E. S. Larsen, Econ. Geol. 23: 398–433. 1928.

Note: Since this address was delivered, a paper by W. K. Gummer (Journ. Geol. **51**: 503–530. 1943) on the system $CaSiO_3$–$CaAl_2Si_2O_8$–$NaAlSiO_4$ shows that crystalline alumina (βAl_2O_3 in this case) can exist at the liquidus on the join between $NaAlSiO_4$ (nephelite) and $CaAl_2Si_2O_8$ (anorthite) as well as at the liquidus in the ternary system $CaSiO_3$–$NaAlSiO_4$–$CaAl_2Si_2O_8$. The petrologic significance is discussed in the paper.

BOTANY.—*Irregular barley*, Hordeum irregulare, *sp. nov.*[1]

Ewert Åberg, University of Wisconsin and Bureau of Plant Industry, Soils, and Agricultural Engineering, and G. A. Wiebe, Bureau of Plant Industry, Soils, and Agricultural Engineering. (Communicated by M. N. Pope.)

One of the types of barley endemic to Abyssinia is best described by a single word, irregular. The late Dr. H. V. Harlan used this term in 1914 (*6*, p. 24) when he stated: "Aside from the observations upon established forms, it has been the fortune of the writer to isolate a number of which there seem to be no published descriptions. These all came from Abyssinian barleys, and as the work is not yet completed, only a general indication of the results need be given here. . . . In barleys received from the same region, there is a group with a curious,

[1] Received February 22, 1945. Cooperative investigations between the Wisconsin Agricultural Experiment Station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture. Published with the approval of the Diector of the Wisconsin Agricultural Experiment Station. Supported in part by a Research Grant from the Wisconsin Alumni Research Foundation.

irregular, yet heritable, habit of floret abortion. In the ripened spike the spikelets are normal at the base and for a varying distance toward the tip. The upper portion usually reduces suddenly to a 2-rowed form. In this case the lateral spikelets are not merely sterile, but are reduced to only the outer glumes and the rachilla, the floret having disappeared entirely. The spikes are found to present these modifications even when the head first emerges from the boot. The actual time of the reduction has not been determined but it is so early that no scar is present, indicating that the floret never started to develop."

Harlan continued orally to use the term, irregular barleys, for the type he described in 1914, but unfortunately it never became established in the literature nor came into general use. This is to be regretted, as there is a real need for this term in the barley classification, and especially so since the terms which have gradually come into use instead are confusing and not at all as descriptive as the one Harlan applied.

It appears that the irregular type of Abyssinian barley was collected once by A. F. W. Schimper in the middle of the nineteenth century. It was grown by Al. Braun in the Botanical Garden at Freiburg in 1848, but at that time it was regarded only as a transition form between 6-rowed and 2-rowed barley. This is evident from a statement in "Sitzungsberichte des botanischen Vereins der Provinz Brandenburg" published in 1875 (*12*, p. 437). There it is stated: "Herr Wittmack legte eine grössere Zahl von Schimper in Abyssinien gesammelter Gerstenähren vor, die er theilweise von Herrn Prof. Braun, theilweise von Herrn Dr. Grönland erhalten hatte, und wies an mehreren den Uebergang von 4-zeiliger Gerste[2] in zwei-zeilige nach, ein Uebergang, der bei unseren Culturen sich nie zeigt, aber bei den vom Prof. Braun in Freiburg i/Br. 1848 angestellten Aussaatversuchen der abyssinischen Gersten widerkehrte." The fact that this Abyssinian type appears morphologically to occupy an intermediate position between 6-rowed and 2-rowed barley later undoubtedly led to the use of the term "intermediate" and also to the Latin name *Hordeum intermedium*, although the latter never was intended for that type.

In 1882 Körnicke (*8*, pp. 185–186) described as *Hordeum vulgare* L. subsp. *intermedium* a barley type with awned central florets and awnless lateral ones. The lateral seeds are markedly smaller than the central ones but germinate when seeded. In 1885 Körnicke (*9*, pp. 172–174) gives the same description, only adding that in one of the varieties of the subspecies, var. *Haxtoni* Kcke., not all lateral florets are fertile. The florets are, however, fully developed. In 1916 Carleton (*3*, p. 124) and in 1918 Harlan (*7*, p. 12) used the same description for the species *Hordeum intermedium* Kcke. Harlan's description of *Hordeum intermedium* in 1918 does not include the irregular type of Abyssinian barley that he discussed in 1914. The first time this type is again mentioned in the literature is by Engledow in 1924. Previous to that date it was discussed in correspondence between Harlan and Engledow.[3] Judged from a letter to Harlan on January 29, 1921, Engledow had found the irregular type among Abyssinian barleys in 1920. From Harlan's reply on February 23, 1921, it is clear that Harlan, at that time, knew about the variations in irregular barleys from the type with occasional lateral seeds to those with practically all lateral seeds fully developed, but he did not classify them with any other group of barleys. Engledow's description in 1924 places the irregular barleys as exceptional forms of *Hordeum hexastichum* or *Hordeum decipiens*. He placed them with *Hordeum hexastichum*, when an occasional lateral floret was missing, and with *Hordeum decipiens*, when many of the lateral florets were missing. In regard to the stability of the character he points out (*4*, p. 58), that "in three successive seasons this peculiarity has been maintained and it is, therefore, to be regarded as a constant and heritable attribute."

Körnicke's description of *Hordeum vulgare* L. subsp. *intermedium* remained valid and was applied only to the type of barley

[2] The "4-zeilige Gerste" in the early literature is equivalent to the 6-rowed barley of the present-day literature.

[3] Correspondence between Harlan and Engledow filed in National Archives, Washington, D.C.

FIG. 1.—Spikes of irregular barley, *Hordeum irregulare* E. Åberg and Wiebe, of Abyssinian origin showing the variation found in number of missing lateral florets. *A*, Many lateral kernels missing (C. I. 5843); *B*, some lateral kernels missing (C. I. 3210–5); *C*, occasional lateral kernels missing (C. I. 1238).

for which it was intended, even during the period when Harlan and Engledow worked with irregular Abyssinian barleys. In 1929, when Orlov gave a description of barleys from Abyssinia and Eritrea, he brought the irregular barleys in under the subsp. *intermedium* Kcke. (*10*, pp. 317–333, 344–345), thereby causing considerable confusion. According to his description of subsp. *intermedium* Kcke., the lateral spikelets may be fertile or sterile, in the latter case consisting of glumes, lemma and palea, or they also may be completely reduced so that only the glumes are developed. Considerable variation occurs in the number of fertile and sterile spikelets on the spike, which is useful as a means of classifying varieties. No mention is made of the type of awn on the lemmas of central and lateral florets.

In 1936 Orlov (*11*, pp. 228–229) included the irregular barleys under subsp. *intermedium* Vav. et Orl. (subsp. nov.) and pointed out that this subspecies is sharply distinguished from subsp. *intermedium* Kcke. The characteristics for subsp. *intermedium* Vav. et Orl. are that a varying number of spikelets (one, two, or three) with normal kernels develop at each node of the rachis of the spike. See also Åberg (*2*, p. 18).

As editor of the Russian publication *Classification of Cereals*, Flaksberger pointed out in an editor's note (*5*, p. 342) that he thought it would have been more nearly correct for Orlov to have retained the use of subsp. *intermedium* Kcke., for the intermedium group of barleys as described by Körnicke. Flaksberger also suggested that *interjectum* could be used for the Abyssinian intermediate barleys (irregular as used in this paper).

Unaware of Harlan's suggestion and continued use of the term "irregular," for the Abyssinian intermediate type, Åberg (1940) also applied *Hordeum intermedium* (Kcke.) Carleton to barley of this type (*1*, pp. 102–106).

From this review it is evident that there is a great deal of confusion among workers in the use of these terms. The Latin name *Hordeum intermedium* has been applied to two types of barleys that in reality are distinct. The terms intermedium, intermediate, and Abyssinian intermediate are used and each has a very definite and specific meaning. Unfortunately, however, they sound very nearly alike and appear very similar in print.

It seems desirable, therefore, to make the following disposition: (1) Retain "*intermedium*" essentially as used by Körnicke in *Hordeum vulgare* L. subsp. *intermedium* for that type of 6-rowed barley in which the lateral kernels are reduced in size and their lemmas awnless. It is further suggested that Körnicke's subspecies be regarded as a variety and used as *Hordeum vulgare* L. var. *intermedium* Kcke. (2) Use the term "intermediate" in a broad sense to describe plant characters that are midway between extremes or limits, as, for example, leaf size may be intermediate; and also to describe in a broad way heterozygous genetic types like the F_1 of a 6-rowed $\times$2-rowed barley cross. (3) Replace "Abyssinian intermediate" with "irregular," which latter name was suggested by Harlan as early as 1914. To achieve this the irregular barley, which have been erroneously included under "*Hordeum intermedium,*" are here segregated as distinct and described as a new species as follows:

Hordeum irregulare, sp. nov.

Rhachi spicae dura; spiculis centralibus fertilibus, lateralibus aliis fertilibus aliis sterilibus, aliisque sine staminibus vel pistillis pro parte ad rhachillas in spicam irregulariter dispositas reductis.

Irregular barley with tough rachis. The central florets fertile; lateral florets reduced to rachilla in some cases and these distributed irregularly on the spike, the rest of the lateral florets of only one of the following types: fertile, sterile, or sexless (Figure 1).

Type: No. 161999, herbarium of the U. S. National Arboretum, grown at Plant Industry Station, Beltsville, Md., February 1945, from seed collected by H. V. Harlan at Lalibela market, Abyssinia, on January 7, 1924, from cultivated plants. (C. I.[4] No. 3908-3, Division of Cereal Crops and Diseases, Bureau of Plant Industry Station, Beltsville, Md.)

[4] C. I. refers to accession number of the Division of Cereal Crops and Diseases.

According to the above, the division of the section *Cerealia* Ands. of the genus *Hordeum* L. as given by Åberg (*1*, p. 119) is revised as follows:

H. agriocrithon	E. Åberg
H. spontaneum	C. Koch
H. vulgare	L. emend. Lam.
H. irregulare	E. Åberg and Wiebe
H. distichum	L. emend. Lam.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

NEW MEMBERS

There follows a list of persons elected to membership in the Academy by vote of its Board of Managers, during the Academy year 1943, who have since qualified as members in accordance with the bylaws of the Academy. The bases for election are stated with the names of the new members.

RESIDENT

William Sidney Benedict, physical chemist, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C., in recognition of researches in the spectroscopy of polyatomic molecules and application of spectroscopy to kinetic studies of mixtures of isotopes.

Merrill Bernard, supervising hydrologist, U. S. Weather Bureau, Washington, D. C., in recognition of original researches in hydrology.

Clifford Allen Betts, engineer, U. S. Forest Service, Washington, D. C., in recognition of contributions to the development of hydraulic structures, including research on the generation of heat in concrete and the design of water tunnels.

Charles Louis Critchfield, mathematical physicist, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C., in recognition of contributions to the theory of nuclear forces in atoms.

Lloyd George Henbest, associate geologist, U. S. Geological Survey, Washington, D. C., in recognition of work on micropaleontology, particularly the fossil Protozoa, and on stratigraphy.

Joseph Oakland Hirschfelder, assistant professor of chemistry, University of Wisconsin; consultant, National Defense Research Committee, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C., in recognition of work on the equations of state of gases and liquids, reaction kinetics, and molecular quantum mechanics.

Emery Clarence Leonard, botanist, U. S. National Museum, Washington, D. C., in recognition of work on the flora of Haiti and on the mosses and Acanthaceae.

Glenn Lane Parker, chief hydraulic engi-

neer, U. S. Geological Survey, Washington, D. C., in recognition of services in the field of water supply engineering, and in particular the development of techniques for making water supply, storage power, and irrigation analyses.

Charles Elmer Resser, curator of invertebrate paleontology and paleobotany, U. S. National Museum, Washington, D. C., in recognition of work in Cambrian stratigraphy and paleontology.

Roger Gordon Bates, associate chemist, National Bureau of Standards, Washington, D. C., in recognition of contributions to the physical chemistry of electrolytes, and in particular researches on the thermodynamics of bi-univalent electrolytes and the pH values of standard buffer solutions.

Samuel Whittemore Boggs, geographer, United States Department of State, Washington, D. C., in recognition of contributions to political geography and cartography.

Donald Clarke Boughton, zoologist, Bureau of Animal Industry, Beltsville Research Center, Beltsville, Md., in recognition of contributions to our knowledge of coccidia and coccidiosis of birds and livestock.

Elbert Luther Little, Jr., senior dendrologist. U. S. Forest Service, Washington, D. C., in recognition of distinguished services in the biological sciences, especially in the fields of forest ecology and dendrology.

George C. Manov, assistant chemist, National Bureau of Standards, Washington, D. C., in recognition of contributions to physical chemistry, and in particlar work in thermodynamics and in the determination of pH values of standard buffer solutions.

Henry Stevens, principal biochemist, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, Washington, D. C., in recognition of fundamental and pioneering application of methods of immunochemistry to agricultural problems with particular reference to gossypol and other problems of sensitiveness connected with cotton.

Howard Bancroft Andervont, principal biologist, National Cancer Institute, Bethesda, Md., in recognition of original investigations in the fields of filterable viruses and experimental cancer.

Hugo Bauer, chemist, National Institute of Health, Bethesda, Md., in recognition of chemical advances in chemotherapy.

Harold William Chalkley, senior physiologist, National Cancer Institute, Bethesda, Md., in recognition of services to the science of biology, particularly work on the physiology and chemistry of cell divisions.

Helen M. Dyer, research fellow, National Cancer Institute, Bethesda, Md., in recognition of contributions to research in chemotherapy, metabolism of sulphur-containing amino acids, and cancer studies.

Wilton Robinson Earle, senior cytologist, National Cancer Institute, Bethesda, Md., in recognition of outstanding researches in the technique and study of tissue culture, in particular studies of the production of malignant cells from normal fibroblasts by the action of a chemical carcinogenic agent.

John Fee Embree, senior archivist, War Relocation Authority, Washington, D. C., in recognition of studies of village communities in Hawaii, which led to important work for the Office of Strategic Services, and for the War Relocations Authority on the Japanese in America.

Emily Walcott Emmart, associate cytologist, National Institute of Health, Bethesda, Md., in recognition of the publication of the Badianus Manuscript, and especially for accomplishments in research (1) in the application of tissue culture techniques to the study of cancer and (2) in the culture of the tubercle bacillus on animal membranes, the latter making possible a rapid and effective method for studying drug therapy.

Margaret Dorothy Foster, associate chemist, U. S. Geological Survey, Washington, D. C., in recognition of work on the geochemical relations of ground waters in the Coastal Plain and improvements in methods for the analysis of minerals.

Michael Fleischer, geochemist, U. S. Geological Survey, Washington, D. C., in recognition of work in inorganic and mineralogical chemistry.

Maurice Theodore James, associate entomologist, Bureau of Entomology and Plant Quarantine, Washington, D. C., in recognition of contributions to the taxonomy of insects.

Solomon Kullback, cryptanalyst, Signal Corps, U. S. Army, Washington, D. C., in recognition of contributions to mathematical statistics.

David Goodman Mandelbaum, Division of

Special Information, Office of Strategic Services, Washington, D. C., in recognition of contributions to the Ethnology of the Cree Indians of Canada; the Social Organization of South India tribes; and important work for the Office of Strategic Services.

MONROE HARNISH MARTIN, associate professor of mathematics, University of Maryland, College Park, Md., in recognition of contributions to mathematics, in particular to the "three body problem" in Celestial Mechanics.

ALBERT NELSON SAYRE, senior geologist, U. S. Geological Survey, Washington, D. C., in recognition of investigations in geology and hydrology, especially in regard to the occurrence of ground water in Texas.

FLORENCE MARIE MEARS, associate professor of mathematics, George Washington University, Washington, D. C., in recognition of contributions to the theory of infinite series, wherein research of recognized merit has been done.

MURRAY J. SHEAR, principal biochemist, National Cancer Institute, Bethesda, Md., in recognition of investigations on physico-chemical mechanisms of bone formation; carcinogenesis by chemical compounds; and chemical treatment of tumors.

DEMITRI BORIS SHIMKIN, Major, U. S. Army, Military Intelligence Service, East European Division, Washington, D. C., in recognition of contributions to the ethnology of the Wind River Shoshone Indians, theoretical works on problems of interaction of culture and personality; and important research on Siberia for Military Intelligence Service.

HERBERT CECIL SPICER, associate geophysicist, U. S. Geological Survey, Washington, D. C., in recognition of work in geophysics and geophysical methods of investigation.

ROLLIN ELBERT STEVENS, chemist, U. S. Geological Survey, Washington, D. C., in recognition of work in mineralogical and geological chemistry.

JOSEPH MANSON VALENTINE, associate entomologist, U. S. Bureau of Entomology and Plant Quarantine, Washington, D. C., in recognition of basic work on the classification of Coleoptera, and more especially contributions on speciation and raciation in insects.

CHESTER BURLEIGH WATTS, principal astronomer, U. S. Naval Observatory, Washington, D. C., in recognition of the invention of various devices for increasing the precision of observation of star positions; development of accurate methods for transmitting time signals with especial application to longitude determinations; and determinations of precise positions of comets, planets, and the moon.

FRANCIS JOSEPH WEISS, consultant, Board of Economic Warfare, Washington, D. C., in recognition of work in the fields of chemical economics; world crop insurance; utilization of waste products; economic development and planned utilization of Alaskan resources; chemical utilization of peat and seaweed.

MAXWELL MCMICHAEL KNECHTEL, geologist, U. S. Geological Survey, Washington, D. C., in recognition of work on the geology of (1) mineral fuels in Angola, Venezuela, Montana, and Oklahoma; (2) ground water in southeastern Arizona; (3) Pleistocene glacial phenomena in northcentral Montana; and (4) manganese deposits in Augusta County, Va.

MICHAEL GOLDBERG, engineer, Bureau of Ordnance, Navy Department, Washington, D.C., in recognition of contributions to mathematics.

RONALD BAMFORD, professor, University of Maryland, College Park, Md., in recognition of outstanding contributions in the field of botany, particularly with reference to cytology.

RICHARD STEVENS BURINGTON, associate professor of mathematics, Case School of Applied Science (on leave), consulting mathematician and mathematical physicist, U. S. Navy, Washington, D. C., in recognition of contributions to pure and applied mathematics, in particular to electric circuit theory.

GEORGE TOBIAS FAUST, associate mineralogist, U. S. Geological Survey, Washington, D. C., in recognition of work in mineralogy and petrology.

NONRESIDENT

EDWARD C. RANEY, instructor in zoölogy, Cornell University, Ithaca, N. Y., in recognition of contributions to our knowledge of the fresh-water fishes of eastern North America.

ABRAHAM SINKOV, cryptanalyst, Signal Corps, U. S. Army, in recognition of contributions to algebra, in particular to the theory of finite groups.

ROBERT BIGHAM BRODE, professor of physics, University of California, Berkeley, Calif., in recognition of work on electronic phenomena in gases and metal vapors, and on cosmic rays.

ROBERT S. CAMPBELL, assistant chief, Division of Range Research, U. S. Forest Service,

New Orleans, La., in recognition of contributions in the field of range research, and in particular for pioneering work in the development of range utilization standards.

F. G. Brickwedde, *Secretary*

BOTANICAL SOCIETY

The meetings for 1944 (except the banquet) were held in the Auditorium of the Cosmos Club, President J. R. Magness or Vice-President Egbert H. Walker presiding. Attendance ranged from about 60 to 100 persons. Other officers for the year were: Glenn Greathouse, Treasurer; Miss Mary G. Van Meter, Corresponding Secretary; Mrs. Annie May Karrer, Recording Secretary; F. V. Rand and R. K. Beattie, counsellors; L. E. Yocum, representative to the Washington Academy.

Nine new members were elected during the year: John R. Bowman, Lt. Harold C. Bold, Jean Turpin, Oscar R. Mathews, Miss Jane Roller, Floyd A. McClure, Herbert F. Bergman, Mrs. Helen White Williams, and Curtis May.

Two members died during the year: Lt. Col. George E. Halliday, formerly assistant biochemist in the U. S. Department of Agriculture, killed in action in Italy on July 25; and Lyster H. Dewey, in charge of fiber crop investigations of the U. S. Department of Agriculture from 1890 to 1935, on November 27.

The formal programs were prefaced by book reviews and comments on observations of botanical interest and were followed by a social hour with refreshments. A list of the papers presented is given herewith. Brief résumés of these papers are included in the minutes.

334th Meeting, January 4

The botany of the flat-rocks of the Southeast. Rogers McVaugh, Bureau of Plant Industry.

A botanical trip through North Carolina. D. S. Correll, Bureau of Plant Industry.

335th Meeting, February 1

Some current research objectives and field observations on cinchona in Central and South America. W. C. Davis, Office of Foreign Agricultural Relations.

Pasture and forage crops and their utilization on tropical American farms. Ralph E. Hodgson, Bureau of Dairy Industry.

336th Meeting, March 7

Invitation to study of Western Hemisphere bamboos. F. A. McClure, Smithsonian Institution.

The Pan American Highway in Central America and its botanical aspects. Arthur Bevan and W. A. Dayton, U. S. Forest Service.

337th Meeting, April 4

Our native orchids. P. L. Ricker, Bureau of Plant Industry.

Developing American Easter lilies to replace stocks formerly received from Japan. S. M. Emsweller, Bureau of Plant Industry.

Banquet Meeting, April 25

The annual banquet was served at All Souls Unitarian Church with 188 persons present, including five honor guests: E. D. Merrill, Joseph F. Rock, C. R. Ball, H. L. Shantz, and H. B. Humphrey. The last three were honored in accordance with the Society's custom of so recognizing the retirement of its members from active professional life. The group enjoyed a talk by Liberty Hyde Bailey, author and horticulturalist, formerly of Cornell University, on his botanical experiences of the past half century.

338th Meeting, June 6

Preservation of plant specimens in as nearly a natural condition as possible. G. R. Fessenden, Bureau of Plant Industry.

Strawberry breeding. G. M. Darrow, Bureau of Plant Industry.

339th Meeting, October 3

Two years in China advising on potato improvement. Theodore Dykstra, Bureau of Plant Industry and Division of Cultural Relations, State Department.

340th Meeting, November 7

Exploring for rotenone in Colombia. F. J. Hermann, Bureau of Plant Industry and Foreign Economic Administration.

Phloem necrosis disease of elm. Curtis May, Bureau of Plant Industry.

341st Meeting, December 5

Botanist abroad; or A philosophy for the "Good Neighbor." W. A. Archer, Office of Foreign Agricultural Relations.

Climatic analogues for plant introduction purposes. Michael Nuttonzon, United Nations Relief and Rehabilitation Administration.

44TH ANNUAL MEETING, DECEMBER 5

After the reports of the Executive Committee and the Treasurer were read, that of the Nominating Committee for officers for 1945 was presented. There being no additional nominations, the Society voted to instruct the Recording Secretary to cast a unanimous ballot for the following nominees: President, AARON G. JOHNSON; Vice-President, FREDERICK V. RAND; Recording Secretary, NEIL W. STUART; Corresponding Secretary, Miss JANICE S. BROWN; Treasurer, ROSS W. DAVIDSON; Counsellors, SAMUEL L. EMSWELLER and ROBERT L. WEINTRAUB; Representative to the Washington Academy, F. P. CULLINAN.

ANNIE MAY KARRER, *Recording Secretary*

Obituary

JOHN FRANKLIN MEYER, retired member of the Washington Academy of Sciences, died on October 30, 1944, after an illness which had confined him to his home for more than four years. Dr. Meyer was born in central Pennsylvania on March 11, 1875. He came of "Pennsylvania Dutch" stock and was a good example of that stable and dependable element of our population.

Meyer graduated from Franklin and Marshall College at the age of 19. For 15 years thereafter he alternated between teaching and further study. He received a master's degree from Franklin and Marshall in 1897, attended Johns Hopkins University for 3 years, and completed his work for the doctorate in 1904 at the University of Pennsylvania. After five years of teaching (1902–1907) at that institution he went to Pennsylvania State College as professor of physics.

The year 1909 brought two notable changes in his life. He married Ella Jane Mather and left academic work to become director of physical research at the Bloomfield, N. J., works of the Westinghouse Lamp Company. The following four years were a period of rapid development in the lamp industry, bringing an almost complete change from carbon to metal filaments, and Dr. Meyer's industrial experience during this transition was of great value in his later work for the Government.

In 1913, Dr. Meyer came to the National Bureau of Standards as one of a group formed to study technical problems arising in the governmental regulation of public-utility services. He compiled the most complete collection of information on state and city regulations regarding electric service, and this was published by the Bureau of Standards in two editions (1916 and 1923) under the title *Standards for electric service*. In 1923 he was put in charge of the Bureau's section on photometry and illumination and was also made assistant chief of the Division of Electricity. He filled those positions until his retirement and was also given many other responsibilities, particularly in committee work. He had previously been assigned to the staff of the Congressional Commission on Reclassification and took an important part in the surveys of governmental and industrial employment which led to the reclassification of the departmental Civil Service in 1924. He became secretary of the Conference of State Public Utilities Commission Engineers in 1929 and held that office until his retirement. He suffered a stroke during one of the sessions of the Conference in May 1940 and was never able to return to full-time duty thereafter. His retirement took effect on January 31, 1941.

Dr. Meyer belonged to many organizations and was an effective worker in them because of his modesty, good judgment, and sincere interest in furthering any good cause. He served the Academy as an editor of the JOURNAL from 1918 to 1921. He was a member of the Philosophical Society of Washington, American Institute of Electrical Engineers, Illuminating Engineering Society, Optical Society of America, the Masonic Order, Acacia fraternity, Phi Gamma Delta, Phi Beta Kappa, Sigma Xi, and the Cosmos Club. Besides his technical activities he maintained a lively interest in religious and social questions and in educational work, being a member of the Advisory Council of Franklin and Marshall College, a trustee of Catawba College, and an officer of the Evangelical and Reformed Church. While holding administrative positions Dr. Meyer never forgot the interests and the feelings of his fellow workers, and any associate whether of high rank or low could be sure of receiving sympathetic consideration of problems brought to him. He will long be remembered as "one who loved his fellow men."

E. C. CRITTENDEN

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This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued monthly, on the fifteenth of each month. Volumes correspond to calendar years.

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JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOLUME 35 JUNE 15, 1945 No. 6

ETHNOLOGY.—*The mutual-aid and volunteer company of the eastern Cherokee: as recorded in a book of minutes in the Sequoyah syllabary, compared with mutual-aid societies of the northern Iroquois.*[1] F. G. SPECK, University of Pennsylvania, and C. E. SCHAEFFER, Pennsylvania Historical Commission. (Communicated by W. N. FENTON.)

In the progress of field research in the Southeast during the past decade, a growing mass of data describing the institutions and social life of the Cherokee has come into our hands. The Cherokee constitute an important study group of North America whose way of life became strongly and strangely modified more than a century ago by deliberate movement toward acculturation; they took up learning and its institutions through association with Europeans. The Cherokee became literate in about the first quarter of the nineteenth century, by which time one of their intellectual leaders, Sequoyah, the Cherokee Cadmus, had given his people a system of quasi-syllabic symbols, enabling them to record in writing their own cultural properties. Scribes replaced oral transmitters of knowledge. Not only this, but the acquisition of innovations in the whole gamut of their economic life transformed the group from mountain-dwelling hunters and mountain-valley maize-growers into mountainside crop-farmers, husbandmen, artificers, traders, and sedentary villagers in a space of time so short and phenomenally progressive as to arouse the envy and jealousy of the frontier settlers who first brought these changes across the horizon of the "savages."

The aforementioned changes in the cultural trend of the Cherokee are too well known to need reviewing. Such causes furnished the social and political background out of which the Removal Event evolved in 1836. The works of Adair, Timberlake, Royce, and Mooney abound in treatment of this epoch in southern history. Forman, Debo, and Milling, among others, have ably narrated the historical episodes. And the transition from former conditions of life to those of the post-Contact period has engaged the attention of modernly trained anthropologists, such as Olbrechts, Bloom, Gilbert, and Kelly, whose publications have already appeared. The latter group have cross-sectioned and analyzed, through extensive field work among the conservative members of the Eastern Band in North Carolina, the manifold aspects of the physical, spiritual, social, economic, and political elements under historic changes of cultural life.

THE LITERATURE ON COOPERATIVE ENDEAVORS

But now leaving this review we come to a consideration of one characteristic of native life which is increasingly stressed by students in discussions of the structure and functioning of Cherokee society. Reference is thus made by Olbrechts,[2] Bloom,[3] and more exhaustively by Gilbert[4] to the importance of cooperative endeavor and the various Cherokee social forms, both formal

[1] Received January 18, 1945.

[2] JAMES MOONEY and FRANS M. OLBRECHTS. *The Swimmer manuscript: Cherokee sacred formulas and medicinal prescriptions.* Bur. Amer. Ethn. Bull. 99: 1–319. 1932.

[3] LEONARD BLOOM. *The acculturation of the eastern Cherokee: Historical aspects.* North Carolina Hist. Rev. 19 (4): 323–358. 1942.

[4] WILLIAM HARLEN GILBERT, JR. *The eastern Cherokees.* Bur. Amer. Ethn. Bull. 133 (23): 169–414. 1943.

and informal, through which it derives expression. Our primary concern in this paper is with certain of the more formal cooperative units representing voluntary, associative "companies" of men organized for the purpose of mutual aid and charity. In addition to placing on record heretofore unpublished but specifically literal data, we propose to examine these institutions from the standpoint of their wider, historical relationships. Thus the authorities cited above describe in greater or lesser detail the functions of these cooperative bodies, the scope of their activities, and the nature of their formation. In no case, however, has an attempt been made to scrutinize the associations themselves from the viewpoint of the wider background of aboriginal social systems of the Atlantic slope area.

The fact that recent writers on the Cherokee welfare company have refrained from searching farther afield for genetically related institutions obscures its significance as a societal trait shared by the northern Iroquoian linguistic relatives of the Cherokee. Can the mutual-aid agency of the Cherokee be shown to have a historic connection with the similarly associated company reported among the Iroquois (Seneca) by Fenton? If so, does it represent one of the fundamentals of Iroquoian culture predating the separation into northern and southern divisions? Beyond the unquestioned relationship of speech between the two, ethnologists and archeologists have still to define the fundamentals of Iroquoian social ideology as well as correspondence in material culture. Having called attention to the bearing of these thoughts upon the wider aspects of community life in the Eastern woodlands, we may postpone for the present further examination of their latent possibilities.

Reverting to the published accounts of the Cherokee cooperative agencies, the principal facts on record may be briefly summarized as follows: Economic cooperation in Cherokee society, according to Gilbert (p. 307), is manifested both above and below the institutionalized level, in a variety of forms. As representative of the less formal types, he mentions the simple exchange of services and goods between husband and wife, and between neighboring farmers, and certain spontaneous communal activities, i.e., construction of a foot bridge for the common good. The voluntary, organized, associative forms, on the other hand, are represented, among others, by (1) the poor-aid companies and (2) the *gadugi* or mutual-aid associations.

Gadugi.—The Cherokee *gadugi*,[5] or Mutual Aid association, is defined by Gilbert (p. 307) as a "company organized for the purpose of mutual exchange of services and earnings of money." The following data, paraphrased from the same observers' description (p. 212), provide us with an outline of its structure and activities. The *gadugi* is a group of 12 men organized as a corporation. Its services are hired out to white farmers at nominal rates of pay, or allocated, in rotation, to members' farms for four days of the week. The tasks performed include ordinary agricultural activities, such as hoeing corn, "topping" corn for fodder, and clearing land for cultivation. Cash returns derive from an annual division of the corporation's profits or, when desired, through a loan on the common treasury secured by a mortgage on the member's livestock, land, or dwelling. Officials of the *gadugi* include the chief, treasurer, secretary, sheriff or money-collector, and warner, each of whom is elected annually by the members. Of these, the most important are the chief, who hires out the company, and the warner, who is in charge of actual labor supervision. Often two or three women, serving as cook-laborers, are members of the society.

Poor Aid company.—The Poor Aid company differs from the *gadugi* largely in the nature and orientation of its activities. The former is characterized by Gilbert (p. 307)

[5] Bloom (p. 326) notes in passing that "a cooperative, the *gadugh*, was a distinctive feature of Cherokee society. Gatherings for community work were occasions for social diversions and had much the same motivation and aspect as the 'bees' of colonial and rural America." Olbrechts omits any mention of the *gadugi*.

The Cherokee term is *gàdugi·'*, translated as "welfare society" in modern usage, denoting the Red Cross and other organizations operating for public benefit.

as a "form of mutual aid among neighbors when sickness or death disables one of the families." The officials of the poor-aid agency, according to Gilbert (p. 213), consist of a chief, undertaker, secretary, grave-digger, coffin-maker, and two warners.[6] Of these, the chief serves as director of poor aid while the warners act as his assistants. The association, which is apparently made up of all the able-bodied members of the community, comes together once a year to hold a meeting and elect officers. In the Raven district, where Gilbert carried on his investigation, the annual meeting is held regularly in the community cemetery on August 10.[7] The election is quite informal and usually consists in nomination of popular individuals, by two or three of their friends, and oral assent of the remainder. Following the meeting the assembly cleans up the graveyard and straightens up the tombstones.

The functions of the Poor Aid association consist largely in lending assistance to families in need. For example, if the head of a family falls ill and is unable to provide care for his family, the chief requests the two warners to go around and collect the neighbors. In such an emergency the chief can command the services of the community on three days' notice during the growing season, and at other times immediately. All the able-bodied people turn out to provide firewood and to plow the family's fields, plant and hoe the corn, and, finally, to gather the harvest. In case a family's house burns down, the association also assists in rebuilding and refurnishing it. It is important to note the reciprocal aspect involved, for, as Gilbert (p. 307) points out, "payment for these services is, of course, expected either in kind [chickens or livestock] or in return services."

As suggested by the list of officials previously cited, important cooperative functions were carried out by the Poor Aid association in connection with death and burial. Olbrechts' discussion (pp. 135–38) of its activities on such an occasion follows:

> As soon as it is known that some one has died, the head man of the "grave-digging company" is notified; he, in turn, gives notice to his helpers, and the same day or the next a grave is dug.
>
> The grave-diggers are a company of six volunteers acting under a chief; the latter office at the time of my stay being held by one Gʋla·'ci. They also are appointed for one year, and are elected in the same manner as the coffin makers . . .
>
> The coffin is made by two men acting under a foreman. This "company" is elected for the term of one year, at the same time as the "grave-digging company" and the chief of the settlement.[8]

Upon the close of the mourning rites at the home of the deceased, the corpse is borne to the burial place under the supervision of an aid company official. According to Olbrechts (pp. 137–38):[9]

> At a sign of the chief of the coffin makers, four men will start hunting around for two stout poles or strong boards on which the coffin is put to be carried, and the funeral procession starts . . . Every 200 yards or so the chief of the coffin makers who now acts as a kind of "master of ceremonies," shouts out anìsɔ'i' nɔ·ᵘGwɔ̃ⁿ' ("other ones now"), and four other men, not necessarily belonging to this company, come out of the crowd and take the places of the coffin carriers . . . When the cemetery is reached, the coffin is put down near the grave which has been dug in the meanwhile by the grave-digging company . . .

So much for the guise in which the Cherokee welfare agencies have come down to us of recent years. That they existed in the tribal society of the Southeast in general is satisfactorily acceptable in view of the testimony in the narratives of writers who knew the Creeks and Cherokees in the latter part of the eighteenth century.[10] In

[6] The officials, as given by Olbrechts (p. 80), are the chief and an assistant whose duty it is to call out the members. The former is said to be regarded pretty much as the chief of the community. Farther on in his account (pp. 135–38), he mentions other officers who carry out certain duties in connection with burial.

[7] Olbrechts (p. 80) states that the annual meeting usually takes place "at corn planting time when members have to meet anyway to work for some sick neighbor."

[8] Olbrechts goes on to state, "The election is a very unofficial affair, the members generally being volunteers. The foreman, and if necessary one of the two members, if there are no volunteers, are nominated and usually, ipso facto, elected."

[9] Gilbert's data (pp. 213, 256) follow closely those of Olbrechts on this subject. In another place the former (p. 347) states that formerly every Cherokee town had its undertaker who not only buried the dead but assisted the deceased's family in carrying out certain post-mortem mourning rites.

[10] Gilbert (p. 306) characterizes both agencies (1932) as "aboriginally remnantal organizations

the case of the Poor Aid association, we may refer to William Bartram and his recorded observations on the above-named tribes. He states that "the citizens, as one family, prepare the ground and begin to plant . . . as convenience may direct for general good. The work is directed by an overseer elected or appointed annually, I suppose, in rotation throughout all the families of the town. Thus when a family's private stores fall short, in case of accident or otherwise, they are entitled to assistance and supply from the public granary by applying to the king . . . "[11]

The Poor Aid company, however, underwent progressive disintegration within the last century as the result of influences arising from European contact. We are indebted to Gilbert (pp. 362–63) for a résumé of the events leading to the decline of the cooperative at Yellow Hill, one of the communities on the Cherokee reservation:

In the late 19th century the American Government took over the work of the Quakers in the education of the Cherokees, and began an active program of bringing the younger generation into the Government day schools. In Yellow Hill a manual-training course was set up for the boys, and the latter were taught to make various handicraft objects. Among other things coffins began to be made at this school, and soon the whole town was supplied from this source and the coffin-maker lost his job. The office of undertaker was also made less useful and the whole of the funeral functions of the Poor Aid Society vanished. Soon the effects of the native health and welfare service of the American Government made itself felt and the rest of the functions of the Poor Aid Society vanished also. So it has come about that the cooperative and mutual aid among neighbors in sickness and death have disappeared in favor of direct Government aid in Yellow Hill.

Having surveyed the published material on record for the Cherokee cooperative organizations, we may now set forth additional information on the Poor Aid company as acquired recently from native sources among the Cherokee. These data are taken from a record written in 1932 by Will West Long in the Cherokee syllabary script, and obtained from him in 1944 with a collection of manuscript records in the famous syllabary.[12]

TRANSLATION OF SYLLABARY

Introduction.—In making a translation of the text of the syllabary several difficulties have had to be considered. One of these was the selection of English terms from the vocabulary of West Long to coincide with the sense of the Cherokee original. Such terms as "elected," "votes," "unanimous," "chairman," and "secretary," and others taken from the diction of parliamentary procedure, must impress one as obviously of modern structure and not a part of the basic Cherokee vocabulary of pre-Contact times. The tone of the whole record, in fact, betrays the effect of a far-reaching influence from European sources. There is nothing in such a conclusion to surprise one who recalls that the Cherokee, by the middle of the previous century, had well earned their title

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which function feebly today and seem to be destined to soon disappear." He has collected data to show the presence of the *gadugi* as a cooperative agency among the Cherokee during the early 19th century. The company persisted relatively unchanged until 1890 after which it underwent rapid modifications. It then began, to quote Gilbert (p. 362), to "hire out its services to white people at fixed rates by the day and became in effect an ordinary labor gang. This change in function led to dependence on white people for wages and subsistence instead of a reliance on their own unaided cultivation of the soil by mutual aid. Consequently the association came under the North Carolina regulations as a corporation and became subject to taxation. Unable to meet the taxes from their earnings, the *gadugi* soon declined and mostly disappeared in the opening years of the twentieth century."

Reference is made to this *gàdugi''*, or society, in one of the handwritten journals obtained for the University Museum from West Long himself. Some details of the action of the society are given by one of its members Kètɔgisti', from whom West Long had obtained the records about 1906. It is still untranslated (MS. Book III, p. 67).

[11] Quoted by Bloom, p. 329.

[12] The notebook in which the text was written is a small composition tablet in which West Long, as an officer of the Poor Aid company, wrote down in full the acts, minutes, and proceedings of a meeting held by its members at the Big Cove settlement of the Cherokee in one of its final sessions.

Within the past few years a collection of handwritten books in the Cherokee syllabary, known as the Sequoyah alphabet, has been made and placed in the archives of the University Museum, University of Pennsylvania. The paper submitted is based upon one of these documents. Acknowledgements are due to the Faculty Research Fund of the University, and to Robert Riggs, for support of the initial field work in the area which resulted in securing the manuscripts for the University Museum.

as one of the Five Civilized Tribes of the South. That the cooperative-work units of earlier times should have become organized after the pattern of colonial American town-meetings, is as much to be expected in Cherokee social policies after 1850, let us say, as their progress in literacy,[13] or their change of governmental policy from village to tribal chieftainship and confederacy, and finally, to an elective system with chief executive and house of representatives or councilmen.[14] The data pertaining to acculturative processes at work in the social and political history of the Cherokee have been too well overhauled in the monographs of Bloom and Gilbert, already mentioned, to require more than casual reference in this connection. The proclivity of the Cherokee for progressive acculturation need not surprise one, even under an accelerating momentum between 1720 and 1830, when Bloom's statement is weighed. He asserts, in comparing white frontier and native Cherokee culture, that by 1800 "the frontier presents the intruding culture in a cruder and simpler, perhaps a more elementary form."

In presenting the translation of Will West Long's minute book, we have used parentheses to inclose words not appearing in the original text. The punctuation is that of the present writers, since the syllabary has none. The native terms are transcribed phonetically following the system, with some simplifications, employed by Dr. Olbrechts. Will West Long is responsible for the translation and for the transcriptions and renderings of the personal names listed. It must be remarked that West Long is a purist in Cherokee pronunciation, diction, and style; hence his renderings and etymologies will often vary from those of other speakers who act as informants on Cherokee topics.

Organization and procedure.—Without going into matters that are only indirectly concerned with the functional aspects of the mutual-aid unit, we offer some observations on the procedures of the company during the final meetings held at Big Cove.

West Long remembers that each village settlement community of the Nation, before the era of its political dismemberment in 1836, the time of the Removal to Indian Territory, had what he calls a "lead-chief" or "little chief," *usti·'yu ukαwi·yuhį·'*. Each settlement managed its own affairs of a public, legislative, and social nature as a small independent community unit or tribe. The community chief or "lead-chief" was the social factor in organizing the group's activities and formulating policies. He administered his control through a body of 12 men, known as *ani' tawiskagę·'*, "smooth men," whom he appointed. They served as police or sheriffs, having official authority to arrest and punish, according to tribal mores, men and women guilty of misdemeanor. They reserved the right to decide the degree of punishment for minor offenses by whipping with sticks (four to twelve lashes), or they could even pronounce acquittal. The mutual-aid cooperative, of which we treat, was a branch of this arm of community organization; its officers were appointed by the company itself, and authorized by the community lead-chief. Since it may not find elsewhere a niche in the records of the Eastern Cherokee, it is interesting to note here a fact of band history: West Long remembered that the last lead-chief of the Big Cove Settlement was *Tsiltaɔ'ski·*, "Falling corn-tassel."[15] The office fell into disuse about 1875, according to his recollection. But the aid company at Big Cove continued to function as a work group until shortly after 1932, the date when the text of the last meeting minutes was written. A decade later, as we write, the company still functions in part, although the Agency staff has taken over some of its tasks as a phase of paternalistic policy.

The native designation of the cooperative association, as given by West Long at the time of translating the text, is *uyo'i·yun dahnde'gį·'*, literally "poor people needy (company)." The meeting referred to in the

[13] In 1848 "about three-fourths can read in their own language," meaning the Sequoyah syllabary (Bloom, p. 355, quoting Lanman).

[14] The last a "political instrument modeled on that of the United States" (Bloom, p. 349).

[15] The Anglicized form Chiltoski is still current as a personal name in the band.

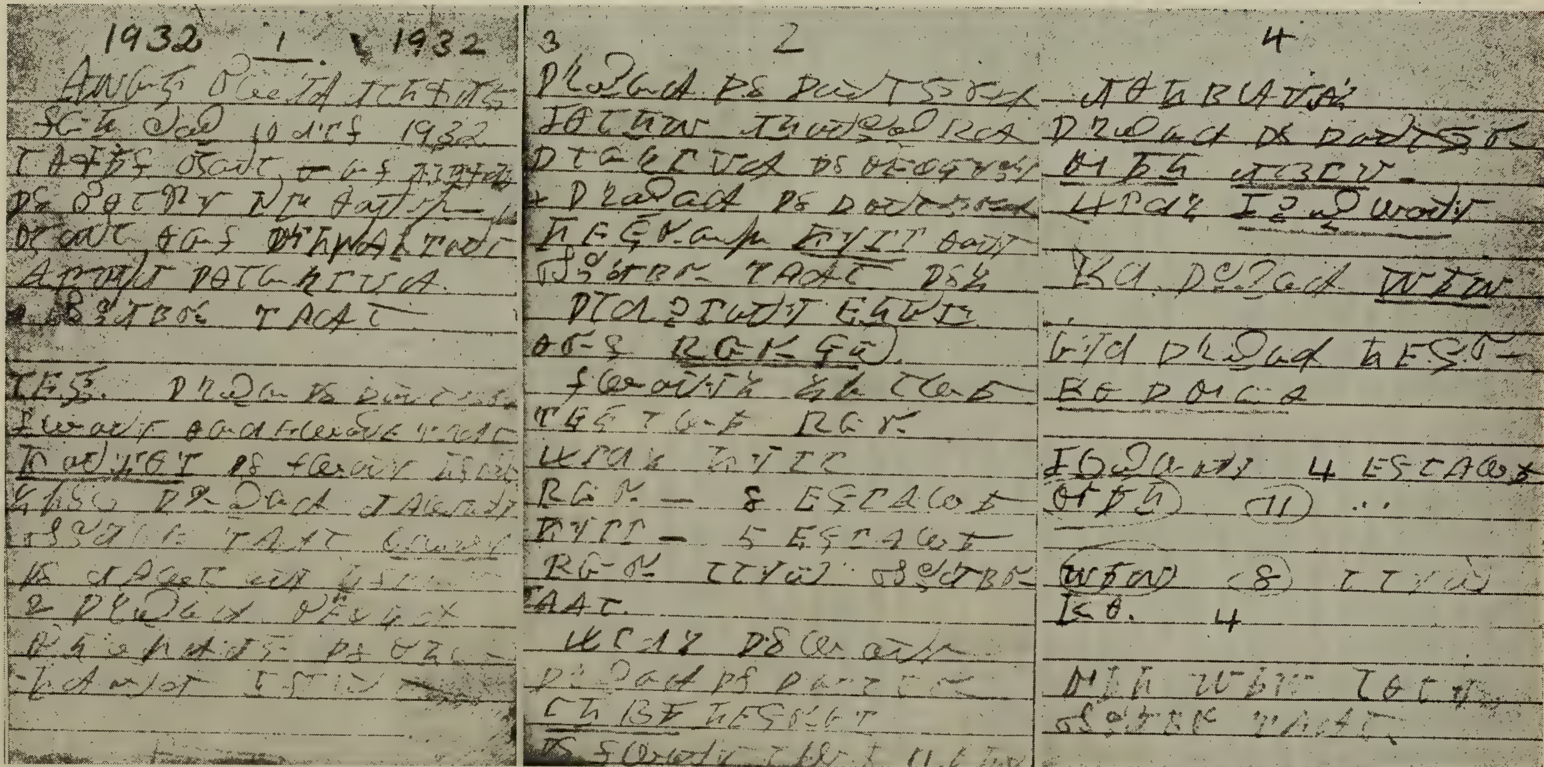

FIG. 1.—Pages 1, 2, and 4 of Will West Long's minutes of meeting of Poor Aid Company, Big Cove settlement of the Cherokee. Written in the Sequoyah syllabary, 1932.

minutes took place at the graveyard at Big Cove as the opening phrase of the text indicates. West Long explained that the outdoor gathering on the occasion was held to clean up the burying ground while the people were assembled for the meeting. (The community has since discovered that the labor of cleaning the graveyard can be saved by pasturing their cattle there to eat off the weeds: Acculturation accelerating economic progress.) The meetings of the organization are now usually held in someone's home. The place is determined by appointment each year and tends to follow a rotation among the families of the settlement.

The tasks of the benefit program of the company fall upon the whole community as ordered by the appointed officers, as West Long, the secretary, explained. This means that, then as now, 20 to 30 persons would constitute the work party. He estimated that about 40 families made up the Big Cove settlement, including those of remote Cherokee descent. Most of them attended the meeting covered in the minutes recorded, and the votes, numbering 27 (page 4 of the text), represent the highest number of males voting on any office of the society, namely, that of notifier.

With this brief review of the occasion, we now turn to the record of the meeting itself.

MINUTES OF A MEETING OF THE MUTUAL AID SOCIETY HELD AT BIG COVE SETTLEMENT, CHEROKEE RESERVATION, N. C. (TRANSLATION OF A DIARY RECORD OF WILL WEST LONG, 1932)

Page 1

Raven's old grave yard, August 10, 1932, held meeting and organized to make as a company, renew it and reelect its officers for as long as one year.

First, motioned it and seconded it, chosen as temporary chairman, Tciskwą'na?į'.[16] Next motioned and seconded, chosen Will Westi[17] as secretary for one year. Third, motioned and seconded, chief head to make speech (explaining) what he has done, also other officers.

[16] Literally "bird going," commonly known in Big Cove as Going Bird.
[17] Cherokee form of Will West (Long).

Page 2

Again motioned and seconded: to person who has had any trouble or sickness, to support and help them; Tcikilili·'[18] will be the head as long as one year.

Then, the volunteer (candidate) to run against (Tcikilili·'), Lloyd Wahi·yα'.[19]

Ordered and given them to vote, voted first Lloyd, then last Tcikilili·'.

Lloyd—8 votes.

Tcikilili·'—5 votes.

Lloyd was elected for one year.

Next, assistant chosen, Djáni Es·i'[20] reelected. Chairman allowed him a vote, ran against him, for one year.

Page 3

Next, dead person's coffin-maker, there should be elected again. Chairman allowed them to vote. Diyelidɔ'[21] should be reelected. They all voted unanimously.

Next, graveyard-digger, motioned and seconded, should be reelected Gwəla'dzi·[22]

Next motioned, Kotagwa'ski·,[23] foreman, appointed against Gwəla'dzi·.

Gwəla'dzi·—5 votes.

Kotagwa'ski·—10 votes.

Kotagwa'ski· elected for one year.

Page 4

Notifier, motioned and seconded, Mason Driver, next Djunu'lαhαski·'.[24]

Next motioned Lasil·a'',[25] motioned elected, reelected Djo'na Amatzoną''.[26]

Djunu'lαhαski·'—4 votes.

Mason—11 votes.

Lasil·a''—8 votes, elected.

Djo'na—4 votes.

Mason, Lasil·a'' elected for one year.

Page 5

Motioned and seconded, Djo'sa Wahiy'ą[27] reelected coffin-maker—elected.

Next, second assistant coffin-maker, mo-

[18] Literally "chickadee," locally known as Chikilili Driver.
[19] Literally "wolf."
[20] Cherokee equivalent of John Jesse (Lawson).
[21] Literally "driver," known as Will Driver.
[22] Literally "echo," known as Gwolidge Wati.
[23] Literally "all day long" (Sunday).
[24] Literally "failer."
[25] Cherokee form of Russel.
[26] Literally "Jonah back in the water"
[27] Equivalent of Joe "Wolf."

tioned and seconded, let it be reelected Djáni Diyelidɔ'hi·.[28]

Motioned and seconded Ma'ka Tsǫtatsį·'[29] assistant.

Djáni Diyelidɔ́hi·—2 votes.

Máka Tsǫtatsį·'—11 votes, elected.

Page 6

Motioned and seconded: if superintendent[30] has an interruption, half-time assistant has to take authority; right to give order to notifier, to help them (people), but first he has to go to find out if it is necessary to help them.

Motioned and seconded: if anyone is an old man, very old and helpless, also some old woman, cannot help herself and is living by herself, he (or she) in anything can be helped; seconded.

Page 7

Foreman or superintendent, to give order must give advance notice three days before, but if it is hoeing corn or cutting wood, then just at any time he has right to give orders to work.

COMPARABLE SOCIETIES AMONG NORTHERN IROQUOIS

Turning now to the northern Iroquoian peoples, or Iroquois proper, we see that the recorded data reveal that patterns of mutual aid and assistance were as characteristic of their economic life as that of their southern congeners. We are indebted to Fenton (p. 43) for information on the type of mutual-aid association existing at the present time among the Seneca of New York State.[31] The Seneca unit is organized not only for joint economic benefit but also incorporates the added function of group-singing for pleasure. Both men and women are members; but the former comprise the singers. The officials of the association differ apparently in number and in scope of duties on the various Seneca reservations. At a recent meeting (1935) on the Tonawanda Reservation, one of these companies, the Salt Creek Mutual Aid and Singing Society, was organized, and a chairman, secretary, treasurer, and two poormasters were elected by the members to serve for one year. The activities of the group include cutting wood for families with sickness, "raising" houses for members, and lending aid to indigent old people. Anyone may approach either of the poormasters and request assistance. When help is thus requested, a "bee" is organized, and, after the day's work, the company sits down to a meal provided by the family in receipt of aid. Parenthetically, it may be pointed out that the reciprocal aspect noted previously for the Cherokee is also present here. After the meal the evening is given over to singing and dancing among the members present. "Similar mutual aid and singing societies prevail at Allegany Reservation, where there were two in 1933–1934, at Cattaraugus, and at Six Nations Reserve" (Fenton, p.c.).

It is worth pointing out that upon two occasions the Salt Creek Singers volunteered to manage funerals in the community (Fenton, p. 42). The cost of lumber having been provided by a state welfare agency, the company delegated to one of its members the task of making the coffin. Thereafter the duties of preparing the body of the deceased, conducting the wake, digging the grave, and preaching the funeral sermon were assigned by the aid association to members of the deceased's opposite moiety.

The modern mutual-aid companies of the Seneca undoubtedly represent a development from native cooperative work groups of the Colonial period. In tracing their antecedents, Fenton (p. 13) notes that, according to current native tradition, "the Singing Societies grew out of groups of men who helped the women . . . Anciently the Chiefs were responsible for the welfare of the people. They could go to a society and ask it to assist a family." Later, the same authority notes, the societies assumed the proportion of singing companies with definite organizations, because of the traditional tendency for Indians to sing and

[28] Equivalent of Johnny "Driver."

[29] Literal equivalent of Mark "Panther."

[30] Referring to Chikilili Driver.

[31] William N. Fenton. *Some social customs of the modern Seneca.* Social Welfare Bull. **7** (1–2): 4–7. New York State Department of Social Welfare, Albany, N. Y., 1935. Also reprinted in Indians at Work **3** (21): 10–14; **4** (6): 41–42. Office of Indian Affairs, Washington, D. C., 1936. Present page references are to the latter source.

dance when gathered in social groupings: the family, the clan, the locality or the nation. "But their original purpose—charity and mutual aid—still obtains."

Another type of mutual-aid association common to the Five Nations of the earlier period is presented to us in a report by Parker.[32] This form differs largely from that described by Fenton in the composition of its membership. Before outlining the data on this second agency, it is necessary first to sketch in the general economic background of the northern Iroquoians. The Five Nations, a group of sedentary agriculturalists like the Cherokee, based their subsistence upon maize-growing. In contrast to the latter, however, Iroquois maize production—planting, cultivation, harvesting, storing, and final processing as food—was carried on almost exclusively by women. Men assisted in clearing the fields, older men occasionally aided the women in cultivation, but the predominant male pursuits were warfare and hunting. Even the chase, at times, was carried on in an intermittent and desultory fashion. Since the burden of economic responsibility was thus borne by women, it is no surprise to learn that cooperative work groups among the Five Nations of the Colonial period were primarily female organizations.

The mutual-aid company that functioned in all agricultural activities was usually composed of women from the entire village. Each year, according to Parker (p. 24), they elected a chief matron to direct their work in the communal fields. These were plots of ground associated with the matrilineal family (clan) or the village as a whole. The produce from the village fields was employed for the preparation of food required in the tribal festivals, the excess frequently being distributed among needy families of the village. The aid-company leader, usually a matron from the dominating family, ordered all the details of planting, cultivating, and harvesting. She was assisted by several lieutenants, matrons selected by her from other family lines. The fields connected with the village were cultivated, one by one, in this way. Early in fall the work company came together to harvest the crops. This was an occasion for festivity, the men attending to take part in the singing and dancing. It is interesting to note Parker's statement (p. 32) that the aid company also tended the crops of sick and injured members, *a service considered as a right and never as a charity* (italics ours). It may be inferred from the above writer that the women's aid association continued to function among the Five Nations down to the last century, by which time male reluctance to participation in agricultural work, under the stimulus of state and federal government and missionaries, had begun to wane.

The existence of still another variety of the cooperative work association is also noted for the Five Nations by Parker. This type functioned in connection with the utilization of certain fields near the village, the use of which was regarded as the property of individual families. According to Parker (pp. 29–30), the women of the community in whom such rights were vested and their husbands or male friends might form a mutual-aid company. Like the exclusive women's work-group previously discussed, the activities of this association were directed by a matron selected from among the members. As long as members' obligations toward cultivation of the communal fields were maintained, they were privileged to carry on the necessary work in their own plots. Few data are afforded us, however, as to the particular role played by male members of the agency except that they helped at husking, knowing that a full pail of corn soup awaited them whether they worked or not. "Often the 'bee' would be enlivened by a marching dance, and for this emergency the men brought their water drums and horn rattles and cleared their throats for singing" (Parker, p. 32). The dual-membership cooperative group is, perhaps, best regarded as a variant of the women's aid-company.

In summary, then, we have presented data describing certain cooperative associ-

[32] ARTHUR C. PARKER. *Iroquois uses of maize and other food plants.* New York State Mus. Bull. 144: 21–32. 1910. Also see ALEXANDER A. GOLDENWEISER. *Early civilization: An introduction to anthropology:* 72–73. New York, 1922.

ations present among the modern Seneca and Cherokee. Further, we have reviewed the more accessible sources for information upon antecedent and coexisting forms in the same cultures for the earlier historical period. Both the recent and earlier types of Iroquoian economic agencies reveal pronounced similarities as well as differences. Despite the dissimilarities, it is the writers' opinion that the two sets of tribal institutions are genetically related, and reflect, in turn, an old, fundamental pattern of institutionalized cooperation and poor-relief characteristic of and deeply embedded in Iroquoian culture. The reasons for so thinking are set forth in subsequent paragraphs.

In delineating the form and function of the economic institutions antecedent to contemporary Iroquoian mutual-aid companies, it is first necessary to set aside those accretions that have attached themselves to the base pattern during the course of recent centuries. Thus, if the Cherokee *gadugi* be screened of such alien elements as the corporate and parliamentary framework of organization, services for hire, loans to members, etc., the simpler form characteristic of the Colonial period remains as a residuum. The primary function of the Cherokee agency is then revealed as mutual exchange of services for economic ends. It is probable that the association during this earlier period was organized on a community-wide basis and operated under the direction of a leader and several assistants. As thus depicted, the parent mutual-aid institution, except for its sexually mixed composition, equates essentially with the women's mutual-aid company of the Seneca. This divergence in membership composition, however, is of relatively minor significance when we recall the peculiar matriarchal trend of northern Iroquoian economy, and contrast it with joint participation of both sexes in agricultural pursuits among the Cherokee.

Similarly the poor-aid company of the Cherokee resembles its Seneca counterpart, the Singing Society, in functioning to alleviate economic distress. Fenton is of the opinion that the contemporary Seneca aid company is the lineal descendant of the sexually mixed cooperative agency described by Parker. In his opinion the latter can be regarded as the parent institution of the Singing Society in the earlier period. A clear line of development, in the light of our present knowledge, can not be traced between the cooperative agency discussed by Parker, and a postulated, dual-composition work-group believed by Quain (p. 249) to function in the onerous activities of land-clearing during the aboriginal period.[33] It is entirely possible that Fenton's "groups of men who helped the women" stemmed from some such aboriginal land-clearing agency. In this case, the dual-composition work-group merely represents the application of the basic pattern of institutionalized cooperation to the smallest, land-using unit in Seneca economy. The mutual-aid element may have become attached to what was once a predominately economic relief agency as the result of the decline in women's agricultural cooperatives and the increasing attention paid by Seneca men to farming.

To return to our comparison of the Seneca Singing Society and the Cherokee poor-aid company, it is clear that both agencies functioned to alleviate distress within the community, whether resulting from life-crisis situations or from ordinary economic need. Upon sifting out the parliamentary elements of organization shared by both, an earlier pattern of supervision, that of a leader and several aides, is revealed. Similarly, the native traits of reciprocity and formalized social diversion are common to the economic cooperatives of both tribes. Further, both Seneca and Cherokee aid companies are characterized by mixed membership since both men and women are members. If we again recall the sexual orientation of Five Nations economy, the society of males who aid the women during the earlier period appears complementary to the coexisting women's farming cooperative, both functioning toward common cooperative and charitable goals. A point of differ-

[33] B. H. Quain, chapter on "The Iroquois" *in Cooperation and competition among primitive peoples:* 240–281. Edited by Margaret Mead. New York, 1937.

ence between northern and southern Iroquoians is the role assigned to members of the Cherokee poor-aid company in execution of certain mortuary rites. These responsibilities accrue to the southern aid-group, apparently, as the result of the widespread Southeastern pattern of individuals other than relatives carrying on the rites leading to inhumation of the deceased. In the northern area, a similar attitude is not lacking in that the deceased's opposite moiety fulfills these obligations. Even here the Seneca poor-aid agency functions in an intermediary capacity. The Seneca aid companies also meet to clean graveyards.

As a result of the preceding analysis, the fundamental pattern of the organized, economic cooperative common to both Five Nations and Cherokee cultures comes to assume proper proportions. If the reconstruction of a prototype institution characteristic of archaic Iroquoian peoples in general be in order, it is to be defined as *a voluntary association of individuals, probably community-wide, organized under the supervision of a leader and several assistants to carry on mutual aid or relief activities within the locality on a reciprocal basis.* The lack of homogeneity in the tribal economic cooperatives of the recent period is assignable to (1) superficial accretions derived from European sources and (2) more fundamental modifications effected by varying streams of influence impinging upon the Seneca and the Cherokee, respectively, subsequent to their separation and dispersion.

As a result of tracing the economic agencies described to earlier levels of Iroquoian history, a fundamental trait characteristic of the cultures of this linguistic family is brought to light. We refer to the pattern of *institutionalization*, which so thoroughly pervades without relaxation the social forms of Iroquoian-speaking peoples in both northern and southern areas. Certainly one would search in vain among the Algonkians of the northern forests for indications of that capacity for economic, political, and social organization which so characterizes the life of their neighbors to the south, the Five Nations. Economic mutual aid is not entirely absent, it is true, among these less complex, hunting-gathering societies. However, it is never manifested through these organized agencies attributable to the Iroquoians but rather through the media of informal work-parties.

In evaluating the observations recorded in this paper, it must be borne in mind that institutionalization appears convincingly to have been an Iroquoian cultural property from the period of discovery down to the present day. We shall have to presume that such a statement is acceptable to students of the group. It is only by means of such a predisposing factor that the rapid assimilation, for example, of Europeans patterns of organization by Seneca and Cherokee alike during recent centuries, is most satisfactorily explained. *The common basis thus provided for the mutual aid groups in both areas affords increased evidence of cultural linkage in the past between two Iroquoian-speaking peoples who differ otherwise in most respects as to their cultural profiles. This substratum of social conformation in Iroquoian cultures represents a field of inquiry about which further information is desired.*

PALEONTOLOGY.—Gaulocrinus, *a new inadunate crinoid genus from the Mississippian.*[1] Edwin Kirk, U. S. Geological Survey.

In the lower Mississippian of Kentucky and Tennessee is a small group of anomalous crinoids. In the main the species have been referred to the Pennsylvanian genus *Stemmatocrinus*, though one has been described as *Mespilocrinus*. Material showing the arm structures has been prepared, and the crinoids prove to represent a new genus.

Gaulocrinus, n. gen.

Genotype.—Stemmatocrinus trautscholdi Wachsmuth and Springer.

Crown. Low, massive, compact.

Dorsal cup. The dorsal cups range from cupuliform (type species) with flattened base and *IBB* not visible in lateral view through cyathiform to crateriform. In the deeper cups the *IBB* are plainly visible in lateral view. In most of the species the plates are very thick. In the holotype of the type species the *RR* have a maximum thickness of 8 mm. The *BB* and *IBB* have approximately the same thickness. This thickness is still greater in larger specimens. The species found in the New Providence of Button Mould Knob is a relatively small one and represented only by dissociated plates and one crushed dorsal cup. Here the maximum thickness of a radial is somewhat less than 4.5 mm. Owing to the great thickness of the plates in most of the species, the cavity of the dorsal cup is relatively small. The plates themselves are pyramidal in form, their dimensions on the inside of the cup being but approximately one-half those on the outside.

IBB. In most of the specimens the *IBB* appear to be fused into a solid disk. The greater part of the specimens, however, are silicified, which militates against accurate observations of sutures in the case of closely united plates. Several specimens seem clearly to show a single suture. In at least two specimens two sutures outlining a single infrabasal can be seen. As the cup is symmetrical there is no way of orienting the sutures as seen. The stellate outline of the infrabasal element in many of the specimens gives good reason to doubt anchylosis of the *IBB*. In all cases known to me where there is anchylosis in the proximal circlet of plates the resultant element has a symmetrical outline without reentrant angles. When two, three, or four elements result from fusion, reentrants are found only where sutures are shown, and even here they are usually not deep. In earlier days a great deal of stress was laid on the number and position of the elements in the proximal circlet. With greater knowledge we have found that such structures may be fairly stable and characteristic in some evolutionary lines and variable in others. Again, sutures may appear in individuals through what Wilson has styled delayed anchylosis. In the case of *Gaulocrinus*, with our present knowledge, the status of the *IBB* may be given as anchylosed with sporadic appearance of sutures. There is a distinct pit for the reception of the column. It is circular, deep, and has vertical walls. The pit is usually submedian in position, but in one undescribed species it seems to be consistently excentric in varying degrees.

BB. Large, usually extending to about one-half the height of the cup wall. An interesting feature in older specimens is the sinuous course of the basal-radial suture.

RR. Large. The radial facet extends nearly the full width of the radial. As seen in lateral view the *R-IBr* articulation ranges from linear to deeply lunate. The straight or slightly excavate contact is shown chiefly in young individuals or in what are assumed to be stratigraphically older species. It may appear, however, within a species in specimens of the same size as those showing decidedly lunate outlines. The distal face of the radial forms a broad platform. There is a well-defined fulcral ridge. The dorsal ligament fossa is relatively narrow but sharply defined. There is also a well-marked ligament pit. The muscular fossae vary with age. In younger speci-

[1] Published by permission of the Director, U. S. Geological Survey. Received March 16, 1945.

mens they are relatively shallow and have a papillose surface. In the largest individuals the fossae are deep and sharply defined. At the lateral ventral margins of the articulating face are triangular facets. Each of these combined with that of the adjacent radial forms a triangular depression that broadens and becomes shallower ventrad. At times, a low ridge delimits the inner margin of the depression. It seems possible that those areas represent interarticular ligament fossae.

Arms. The arms are heavy and short. In the two species where they are preserved, their length is less than the height of the dorsal cup. The *IBrr* are broad, low, and two in number in the two species in which they have been seen. In *G. trautscholdi* the rami do not seem to divide again. In one half-ray there are six secundibrachs preserved. Judging by the rapidity of taper, one would hardly expect another division. In *G. bordeni* there is a second division on the seventh secundibrach.

Tegmen. No part of the tegmen has been found in any instance. In at least one specimen the cup is partially filled with dissociated brachials without recognizable plates that could have been derived from the tegmen. It would appear that the tegmen was an incompetent structure made up of many small plates.

Column. The column is known only in one specimen, where five of the proximal columnals are preserved. The column has a diameter of 5.0 mm and is circular in section. The columnals are of medium height and, as seen, all of approximately the same height. The sides are somewhat rounded. The face of the columnal is marked by fairly strong, radiating ridges. It is not possible to tell the shape of the lumen in the column itself. As shown somewhat indistinctly in the *IBB* it is pentalobate to pentagonal in outline.

Distribution.—*Gaulocrinus* to date has been found in place only in the New Providence of Kentucky and Indiana and an equivalent horizon in Tennessee. Most of the specimens from the White Creek Springs area of Tennessee were found on slopes and bottom lands as float, and their stratigraphic horizon is uncertain. It has been assumed generally that they are derived from the limestones overlying the New Providence equivalent and of approximately Keokuk age, but this is doubtful.

Relationships.—The placement and the differentiation of crinoids with relatively simple structure are difficult. The separation of *Gaulocrinus* from *Stemmatocrinus* is, however, an easy matter on the basis of arm structure alone. *Stemmatocrinus* has long biserial arms. To point out differences between *Gaulocrinus* and species referred to the Permian genus *Calycocrinus* is more difficult, however. Typical *Calycocrinus* has a turbinate cup. The arms are similar to those of *Gaulocrinus*, as for that matter are those of *Edriocrinus* and other widely dissimilar genera. In *Calycocrinus* the articulating face of the radial is narrow, with an indistinct transverse fulcral ridge and a small dorsal ligament pit. There is no platform ventrad and there are no well-defined muscular fossae. The structure is somewhat like that found in such a genus as *Lecanocrinus* and affords some justification for the assignment of *Calycocrinus* to the Flexibilia as now conceived. In *Gaulocrinus* the articulating face is of the type characteristic of many of the heavy-bodied Inadunata. Of what systematic value the articulating faces of the radials may prove to be is a moot point. For our present purposes the striking structural differences shown by the two genera seem sufficient to substantiate the inherently probable wide biologic separation of the two genera.

Species referred to the genus.—

Gaulocrinus bordeni (Springer), n. comb.

Mespilocrinus bordeni Springer, 1920, p. 197, pl. 5, figs. 23a–c: "Knobstone group; Clark County, Indiana" (New Providence).

Gaulocrinus robustus (Troost), n. comb.

Cyathocrinites robustus Troost, 1849, p. 419, *nom. nud.;* 1850, p. 61, *nom. nud.;* 1909, p. 98, pl. 7, figs. 12–14: "Keokuk horizon of the Tullahoma formation. Harpeth River and White's Creek Springs, Davidson County, Tennessee" (Wood). "Harpeth Ridge, Davidson County, Tennessee" (Troost's manuscript locality).

Stemmatocrinus trautscholdi Wachsmuth and Springer (*pars*), Wood, 1909, p. 98.

Gaulocrinus trautscholdi (Wachsmuth and Springer), n. comb.

Stemmatocrinus trautscholdi Wachsmuth and Springer, 1885, pl. 9, figs. 7, 8; 1886, p. 256 (180): "Keokuk limestone near Nashville (White's Creek), Tenn."

Gaulocrinus veryi (Rowley), n. comb.

Stemmatocrinus? veryi Rowley, 1903, p. 133, pl. 38, figs. 7, 8: " . . . probably Keokuk group, of Cumberland County, Kentucky."

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BOTANY.—*Notes on four eastern species of* Gymnosporangium.[1] W. H. Long, Albuquerque, N. Mex. (Communicated by John A. Stevenson.)

This paper reports investigations conducted in 1912 and 1913 in the District of Columbia and vicinity, while the author was in the employ of the U. S. Division of Forest Pathology, on the occurrence of four species of *Gymnosporangium*, *G. clavipes* Cke. & Pk., *G. nidus-avis* Thaxt., *G. effusum* Kern, and *G. juniperi-virginianae* Schw.; on the lesions produced by them on the eastern red cedar (*Juniperus virginiana* L.); and on inoculations made with *G. effusum.*

The purpose of these studies was to determine what species of *Gymnosporangium* occurred in the District of Columbia and adjacent areas, their prevalence and distribution, their action on the host, and to ascertain, if possible, the aecial stage of *G. effusum.*

More than 3,000 red cedars were examined for the presence of *Gymnosporangia*, and a record was made of the distribution on each tree of the species found. Data were taken on the extent and character of the lesions produced. Record for each tree was maintained on an individual card showing size and condition of tree, number of lesions on trunk and branches for each species of rust, nature and size of each lesion, and any other pertinent data, such as nearness to aecial hosts if any, for each locality studied. Table 1 gives a summation of these data, showing number of trees examined, number infected, and number of trunk and branch lesions found for each of the four species of *Gymnosporangium.*

The investigations were made during the months of April and May, as the lesions are most conspicuous during these months because of the swelling and gelatinization of the telia. April was very rainy in 1912, with intermittent showers and often with mists and fogs making ideal conditions for the maturation and gelatinization of the telia.

Three of these species of *Gymnosporangium* are perennial in the red cedar while the fourth is biennial. The prevalence of each species for any given area can be determined from the telial stage more accurately than from the aecial since the former is not dependent for its appearance on the climatic factors for each season. A dry year would reduce very materially the aecial stage for that year, but would not affect to any great extent the perennial lesions in the telial hosts.

[1] Received March 9, 1945.

A study of the table shows that 3,040 red cedars were examined, of which 1,206 were attacked by *Gymnosporangium clavipes*, 382 by *G. nidus-avis*, 165 by *G. effusum*, and 76 by *G. juniperi-virginianae*. *G. clavipes* headed the list with 17,030 lesions, *G. nidus-avis* had 1,650, *G. effusum* 408, and *G. juniperi-virginianae* 897, making a total of 19,985 lesions for the four species.

Gymnosporangium clavipes

This species was widely distributed over the areas investigated and was the most abundant as to number of cedars infected and lesions produced. The older and larger cedars were the most heavily infected (see Table 1 for Arlington Cemetery and Catholic University). None of the areas examined was free of this rust, but in some localities it was rare.

G. clavipes was rarely abundant on trees with open tops or with the lower limbs removed for one-half of the distance up the tree, or, strange to say, on solitary trees in the open with many small branches down to the ground. The trees of the last group have a close, dense growth, and this was especially true for trees 2 to 6 inches in diameter. When *G. clavipes* was sparingly present, *G. nidus-avis* and *G. effusum* were usually absent. Cedars that did not have trunk lesions of *G. clavipes* were often so situated that their trunks were not shaded much and had very open foliage. Apparently most of the trunk lesions originated directly on the trunk and did not start on a small branch or twig and thence work down along the trunk.

This rust traveled more rapidly laterally than longitudinally and did not kill the living bark even in the center of the oldest and largest lesions on trunks and large branches, but killed small branches and twigs by girdling and sapping them of their vitality. The yellowish-red telia were small and inconspicuous under the old dead bark of the trunk and were irregularly scattered over the surface of the lesions. All these were well-marked characters of this rust. No lesions were found on very young twigs, but all were on those with well-developed wood and without needles.

Many trunk lesions were found which apparently originated in the enlarged wood at the base of a branch protected by the loose bark at that point. Such lesions did not originate on the branch proper but at its juncture with the trunk and spread from there to the trunk. One of the largest trunk lesions found was 90 cm wide by 40 cm long, with the outer bark very thick, rough, and blackish over the lesion, which was alive throughout. There were numerous trunk lesions on this tree, but there was no evidence that any of them started from branches and then spread to the trunk.

Gymnosporangium clavipes is well recognized as a serious rust on certain varieties of apples, and the abundance of this species over the areas here reported indicates that it would become a serious menace to apple culture during favorable years in these regions.

Gymnosporangium nidus-avis

This *Gymnosporangium* was also found widely distributed over the areas investigated, coming next to *G. clavipes* in number of cedars, infected and lesions produced. Only one area, Park Lane, Va., was free from this species, possibly owing to the small size and youth of the cedars, which were only half an inch to 2 inches in diameter.

Arlington Cemetery and Great Falls, Va., were the most heavily infected areas both in number of trees attacked (301) and lesions (1,418) produced. This heavy infection probably was due to the size of the cedars involved (2 to 45 inches in diameter) and the extreme age of many of them. This rust produces three types of lesions—trunk, branch, and broom. One hundred out of 1,108 branch lesions and 186 of 483 brooms were dead.

The open type of broom with normal needles found about Washington was quite different in aspect and much larger than the dense brooms with juvenile needles found on *Juniperus virginiana* L. var. *crebra* Fernald & Griscom from Massachusetts. In the material examined from Washington and vicinity no telia or lesions were found on young twigs or among the needles, but they were confined to the limbs and branches with heartwood. The living bark down to the sapwood under and adjacent to the telia was stained a golden-yellow during the maturation and gelatinization period. This was a very marked character by means of which the infected area could often be determined even before the telia were formed. This yellow color was due to small yellowish globules in the rust

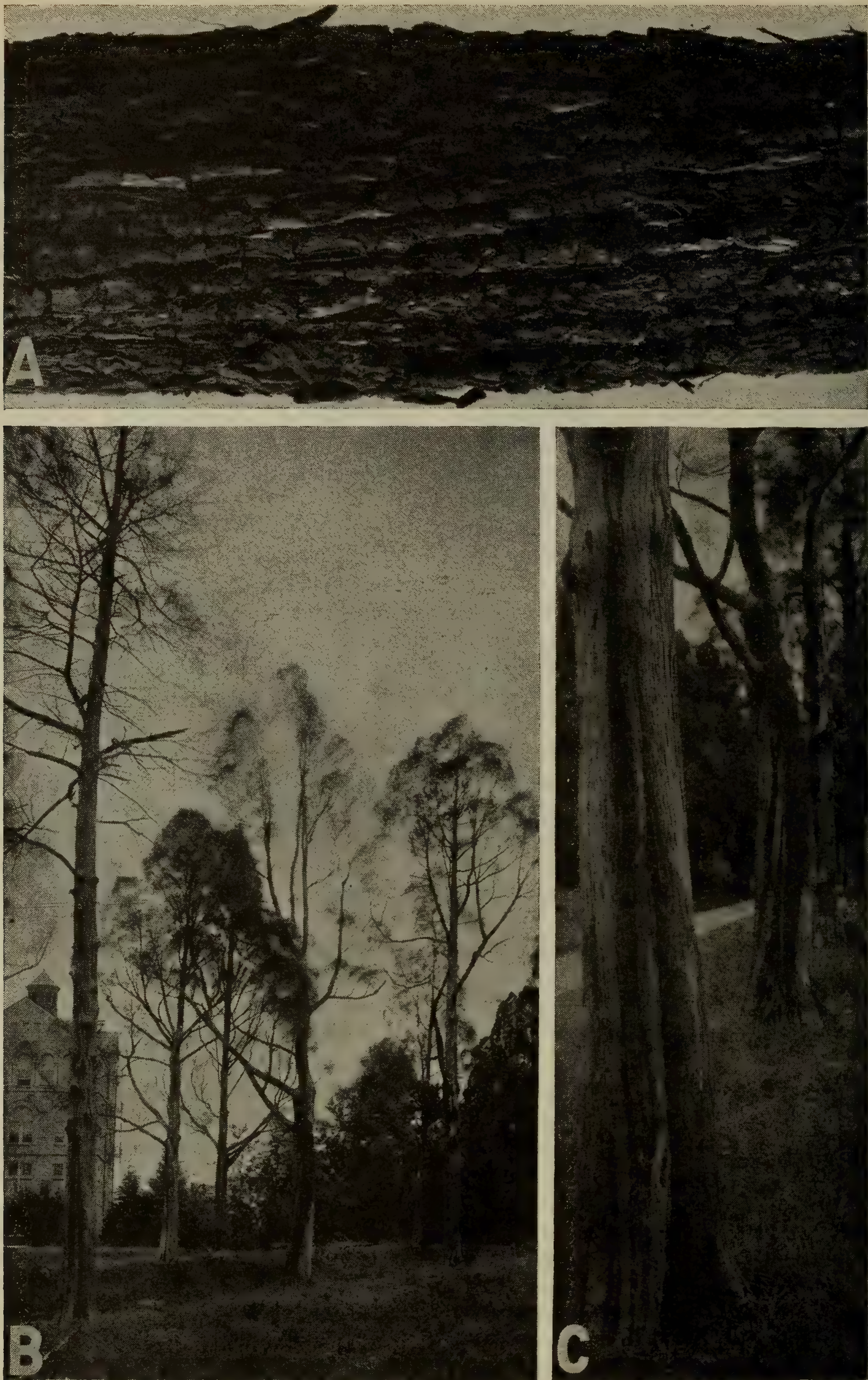

Fig. 1.—*A*, A typical branch lesion of *Gymnosporangium effusum* with its ridgelike galls extending in parallel lines on the diseased area; *B*, a row of red cedars on the grounds of the Catholic University of America at Washington, D. C., dying from the attacks of three species of *Gymnosporangium*, especially *G. effusum*. Note how many lower branches have died and been removed, and the large black trunk lesions due to *G. effusum*; *C*, closeup view showing more clearly the lesions. Through the kindness of the University authorities, the writer learned that all the trees shown in this figure were dead by 1927, except one which, though still alive, has much dead wood on it.

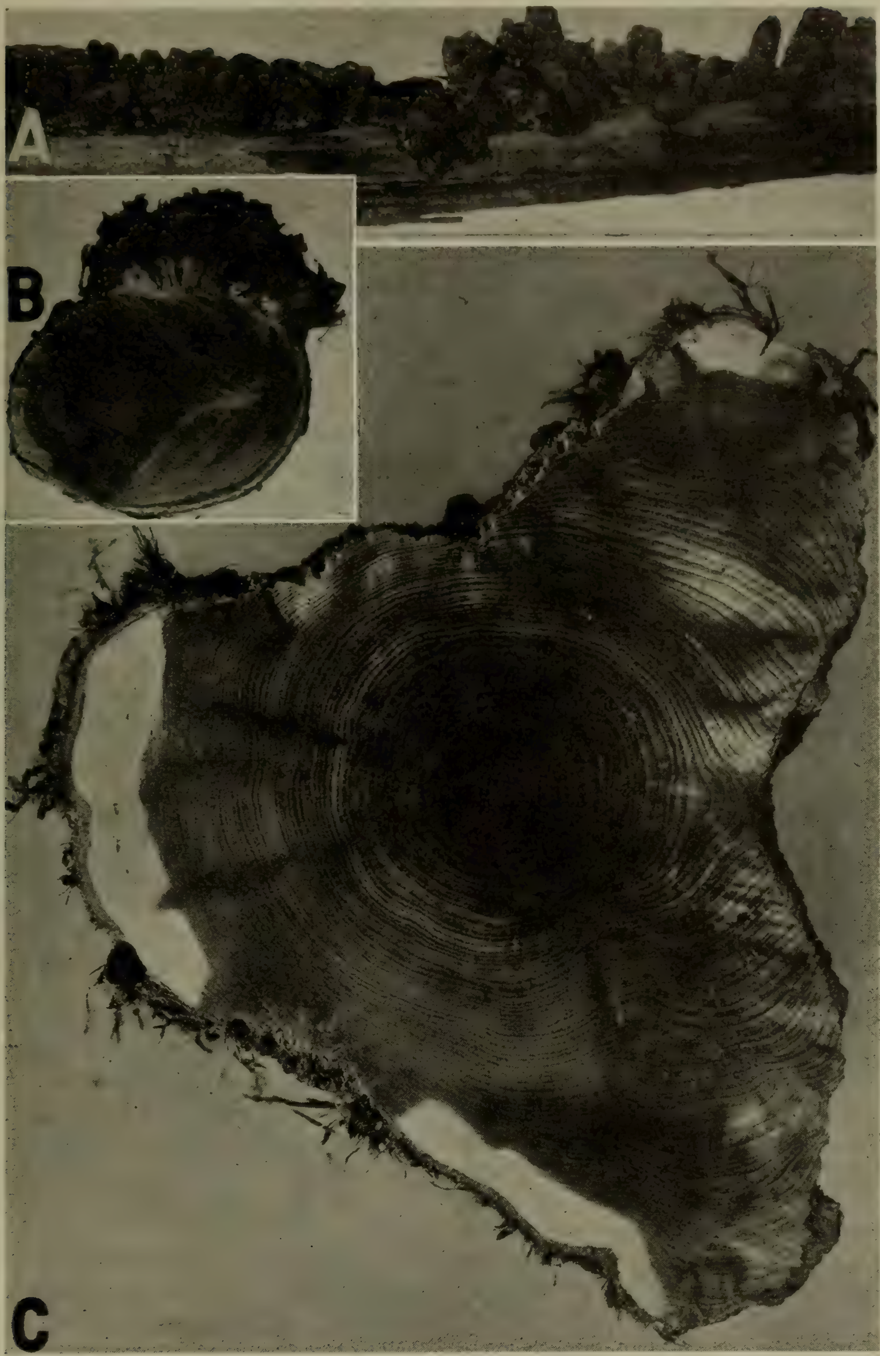

FIG. 2.—*A*, A row of living expanded telia of *G. effusum*; *B*, cross section of a living gall of *G. effusum* with expanded telia, showing the deep seated character of the lesion; *C*, cross section of a red cedar with three major trunk lesions of *G. effusum*, which have practically killed the tree.

hyphae, which occur in the subhymenial layers beneath the telia. In addition to these yellow globules, many suppressed but apparently mature golden-yellow spores were present, but these were not the main cause of the yellow color. In the Sharon, Mass., material of *G. nidus-avis* no yellow color was found in the substratum beneath the telia.

Some of the brooms around Washington, D. C., were very large, being 58 cm long by 77 cm wide, while trunk lesions ranged from 70 cm long by 9 cm wide to 175 cm long by 42 cm wide. One large branch lesion was 350 cm long on a branch 9 cm in diameter, entirely girdling the dying branch for most of its length.

The material of the dense juvenile-needle brooms studied was obtained from Sharon, Mass., through the kindness of the late Dr. Farlow, while the open type of brooms here discussed was found in the District of Columbia and vicinity.

Gymnosporangium effusum

This species was described by Kern (*5*, pp. 459–460) from material collected by him on the Santee Canal in South Carolina in 1909, but since then very little of importance has appeared in print concerning this *Gymnosporangium.*

Lesions of this rust formed deep-seated, woody-corky, truncate, ridgelike galls, which ran longitudinally in parallel rows on branches and trunks of the red cedar. These galls were 2 to 6 mm tall by 3 to 12 mm wide, with "roots" penetrating to the sapwood of the host (Fig. 2B). These ridgelike galls when alive were composed of rather firm cheeselike tissue filled with rich foodstuffs for the development of the telia. After the teliospores matured the galls became brown, more or less suberized, and covered with a corky callus. After one or possibly two years of fruiting these galls died but persisted for years on the old dead areas of the lesions. These ridgelike galls usually checked transversely into pieces 2 to 15 mm long (Fig. 1A).

The infection spread very slowly transversely on the branches and trunks and the new galls developed at irregular intervals next to and on the outside of the old ones and parallel with them. The telia appeared longitudinally in the ridgelike galls, breaking through the surface callus in slits with only one row of flattened telia to each gall. When expanded the telia were wedge-shaped (Fig. 2A), 10 to 12 mm tall by 2 to 6 mm thick at the top by 10 to 30 mm long, often with ends of the telia confluent for 4 to 6 cm, rugose to dentate on top, sometimes tongue-shaped to cristate, as thick at the bottom as at the top or even thicker, rather firm when fully expanded and often falling away in a body leaving a yellowish scar. The fallen telia had a longitudinal slit extending up into their bases for 1 to 2 mm. Telia when expanded were a light watery brown and about one-third to one-half taller than before gelatinization.

Successive years of fruiting on twigs and branches finally killed the lesions by the complete destruction of the cortex, phloem, and cambium. The old galls became dark brown to blackish with age. The surface of the old lesion on the trunk was usually in a depression covered with the corky ridges of the dead lesions. Very old dead lesions had a charred look like a fire scar (Figs. 1B and 1C) caused by the transverse cracking of the corky ridges and the darkening and partial falling out of the cubes of the diseased dead tissue from weathering.

The trunk lesions gradually killed the live wood, and as these lesions extended very slowly transversely the fungus formed a depression in the trunk, which widened as the tree grew until often only a small amount of live wood tissue was left to nourish the tree (Fig. 2C). The tree was finally killed.

Fig. 2C is a fine example of the action of this *Gymnosporangium* on the tree trunk. This cross section shows three large lesions, which through the years gradually killed nearly all the living tissue of the trunk. One of these lesions was 80 years old, the fungus having entered when the tree was 33 years old. The cross section of another trunk showed a 108-year-old lesion that started when the tree was 20 years old. The fungus at the edges of the lesion, by progressive growth in the adjacent wood, prevented any wound callus from forming, thereby keeping the wound open as shown in Fig. 2C, where the small amount of wood still alive can be noted.

The longitudinal growth of the rust lesion ranged from a maximum of 3 inches to a mini-

mum of 1 inch, having an average of 1.5 inches per year with very little appreciable increase in width. No very young lesions were found, the youngest being 72 cm long by 3½ cm wide. It apparently started on the trunk since no limb was near. Many trunks of red cedars had lesions that were largest at the ground line, then tapered upward, as if the lesion started at or very near the ground. Many branches had been killed by being engulfed and surrounded by adjacent trunk lesions. These dead branches were free of any infection above their bases; hence they could only have been killed by being engulfed. Branches were often flattened by lesions, many of which started on the underside.

This is one of the few rusts in which the length of time the rust has been in the tree can be determined, due to the nature of the lesions that it produces. Trees were found that had been infected for 108 years or longer. Trunk lesions ranged from 22 to 1,050 cm long and of those studied 40 were dead. The number of trunk lesions ranged from 0 to 6 per tree. Branch lesions totaled 173, ranging in length from 15 to 425 cm, and of these 37 were dead.

This is the only *Gymnosporangium* so far as is known that kills the cortex, phloem, and cambium down to the xylem. No study was made on how this killing occurred or the method of lateral spread in the host.

Dodge (*4*) discusses the damage done to *Juniperus virginiana* by *G. nidus-avis*. He divides the lesions produced into two types, the effuse and the caulicolous forms, and on page 106, figure 3, gives photographs of the two types of lesions. His figure 3, A, is a good representation of the caulicolous type of lesions produced by *G. nidus-avis*, showing the irregular orientation of the telia on the lesion, while figures 3, B, and 3, G, given as the effuse form of the above species, are typical examples of the lesions produed by *G. effusum*.

Crowell (*3*, p. 473) claims that *G. effusum* and *G. nidus-avis* are the same species as determined from cultures and microscopic studies of the two species. Apparently the data given and the inoculations made by him were based on the caulicolous form of *G. nidus-avis*. The highly characteristic lesions produced by *G. effusum*, so different from any other *Gymnosporangium*, should make it impossible for this species to be confused with any other.

The alternate stage of *G. effusum* has never been positively determined. Arthur (*1*) reported inoculations made in 1911 on *Aronia arbutifolia*, *Amelanchier canadensis*, *Pyrus communis*, *Malus coronaria*, and *Malus malus*. These sowings produced pycnia on *Aronia artibutifolia* but no aecia ever developed and there was no infection on any of the other hosts inoculated. Arthur (*2*, p. 371) made only one set of cultures of this *Gymnosporangium*. During April and May 1912, the writer made sowings with *G. effusum* from *J. virginiana* on the following species of hosts:

Aronia arbutifolia—10 plants, April 19, 1912, and 5 plants, May 8, 1912.

Aronia nigra—4 plants, April 19, 1912; 2 plants, April 29, 1912; and 2 plants, May 8, 1912.

Amelanchier canadensis—4 plants, April 19 and 29 and May 8, 1912.

Chaenomeles japonica—2 plants, April 10 and 19, 1912.

Cydonia vulgaris—2 plants, April 10 and 19, 1912.

Malus coronaria—3 plants, April 10 and 22, 1912.

Malus malus—2 plants, April 10, 1912.

Pyrus communis—2 plants, April 10 and 19, 1912.

Cerasus arbutifolia—1 plant, April 10, 1912.

No infections developed from any of these sowings.

Recently the writer noted that there are only two species of *Gymnosporangium* whose alternate stages are unknown, *G. effusum* for the aecial and *G. hyalinum* for the telial stage. The type locality of both is South Carolina, and the range of each is much the same along the southern Atlantic coast. There is, therefore, a strong probability that the aecial host of *G. effusum* is one or more of the species of *Crataegus* listed for *G. hyalinum*, viz., *C. clara* Beadle, *C. dispar* Beadle, *C. egens* Beadle, *C. egregia* Beadle, *C. michauxii* Pers., *C. munda* Beadle, *C. pexa* Beadle, *C. quasita* Beadle, *C. viridis* L., and *C. visenda* Beadle. It is rather strange that no one so far as known has made sowings of *G. effusum* on any of these or other species of *Crataegus*. *G. trachysorum*, a closely related species, has its aecial stage on *Crataegus*, which is another indication that this host may contain the aecial stage of *G. effusum*.

Gymnosporangium juniperi-virginianae

This species was not very abundant over the

areas investigated. Only areas with young and small cedars had any appreciable number of trees attacked by it; on those areas where the trees were old and large very few or none were infected. In Arlington Cemetery three galls were found, and only one of these was alive. It seems odd that so few trees of the more than 3,000 examined were infected with this *Gymnosporangium*, which is in marked contrast to the large number attacked by *G. clavipes*. Dead galls as well as living ones were counted, and yet the number found was very small, as shown in the table.

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Table 1.—Data on Gymnosporangium Lesions on Juniperus virginiana for Each Area Investigated[1]

Location and diameter of trees	Trees examined	*G. clavipes*			*G. nidus-avis*				*G. effusum*			*G. juniperi-virginianae*		
		Trees infected	Lesions		Trees infected	Lesions			Trees infected	Lesions		Trees infected	Lesions galls	Total lesions
			Trunk	Branch		Trunk	Branch	Brooms		Trunk	Branch			
Arlington Cemetery, 2–45″	555	545	1,730	6,580	169	33	545	433	97	100	89	3	3	9,513
Catholic Univ., 4–28″	93	75	434	1,006	12	4	12	1	33	107	56	0	0	1,620
Roads near Catholic Univ., 16–32″	76	44	40	275	15	1	28	1	22	19	22	0	0	386
Great Falls, Va., 2–6″	405	403	1,697	4,050	132	16	356	45	7	5	2	2	15	6,186
Park Lane, Va., ½–2″	383	4	0	20	0	0	0	0	0	0	0	0	0	20
Fences near Park Lane, 4–12″	388	29	32	119	10	3	33	0	0	0	0	6	63	250
Franklin Park, 2–14″	174	14	42	70	3	0	10	0	0	0	0	36	615	737
Country Club, 4–20″	116	30	200	464	11	1	35	0	0	0	0	1	20	720
El Nido to Franklin Park, 6–14″	49	40	60	115	2	0	4	0	1	0	1	6	40	220
Fence rows, 3–16″	503	7	0	33	14	0	43	4	1	0	1	22	141	222
Scattered trees, 6–12″	298	15	3	60	14	0	42	0	4	4	2	0	0	111
Totals	3,040	1,206	4,238	12,792	382	58	1,108	484	165	235	173	76	897	19,985

[1] Many of the cedars in Arlington Cemetery were being seriously damaged in 1912 by three other enemies in addition to the rusts: a climbing grape vine (*Vitis* sp.) had overrun 75 of them, killing 38; 51 of the trees had poison-ivy (*Rhus toxicodendron*) on trunks and lower branches; while 102 had a butt rot (*Fomes subroseus*), which was destroying the heartwood, thereby weakening the trees.

ENTOMOLOGY.—*Three new species of* Laminitarsus *Fullaway from Singapore and the Philippines* (*Hymenoptera: Braconidae*).[1] YING-TOU MAO, University of California. (Communicated by C. F. W. MUESEBECK.)

In the course of revising the North American species of the hymenopterous subfamily Cardiochilinae the author found three interesting species of *Laminitarsus* Fullaway in the Baker collection at the U. S. National Museum. The genus *Laminitarsus* was first established in 1919 by Fullaway to include only one species from Los Baños, Luzon, Philippine Islands. He placed it in the subfamily Cardiochilinae without further statement.

The species of both *Cardiochiles* Nees and *Laminitarsus* Fullaway have the third abscissa of the radius arched basally, but *Laminitarsus* may be easily recognized by the extraordinarily broadened and lengthened basitarsus of the posterior leg (Figs. 6, 7, 8) and the more or less triangular propodeum.

Four species of *Laminitarsus* are now known and they may be distinguished as follows:

1. Occiput deeply excavated and temple conspicuously bulging posteriorly; second segment of hind tarsus joined apically to basitarsus 2
   Occiput shallowly excavated and temple not bulging much posteriorly; second segment of hind tarsus joined ventrally to basitarsus. *singaporensis*, n. sp.
2. Wings infumated .... *muirii* Fullaway[2]
   Wings hyaline, with only apical fifth of forewing and tip of hind wing infumated 3
3. Face rugose; basitarsus of hind leg about twice as long as remaining four tarsal segments combined.................... *rudis*, n. sp.
   Face smooth; basitarsus of hind leg about one-third longer than remaining four tarsal segments combined .... *chapini*, n. sp.

Laminitarsus chapini, n. sp.

Female.—Length 6.2 mm. Body yellowish brown with the following parts black: Antenna except scape and pedicel, vertex, frons medially, clypeus apically, mesoscutum except anterolateral corner, mesopleuron except dorsally and posteriorly, pectus, base of middle tibia, middle tarsus, two spots on outer surface of hind coxa, hind trochanters, hind femur except apex, hind tibia basally, ventrally, and apically, hind tibial spurs basally, hind basitarsus except medially, the remaining four tarsal segments, a spot on each side of second tergite and apical half of tergites 3 to 5. Fore tarsus except base, spurs of middle tibia, spurs of hind tibia apically, and ovipositor sheath dark brown; wings with apical fifth light fuliginous and the rest hyaline; veins dark.

HEAD: Antenna 41-segmented; scape and pedicel with longer pubescence than the flagellum; eye bare; ocelli slightly elevated; vertex smooth, shining, and slightly sloping towards frons; occiput excavated; frons smooth, shining, impressed, and with a median longitudinal carina; face smooth, shining, and with a short median ridge at upper third; clypeus plain, smooth, shining, and not notched at the median apical margin; maxillary palpus prominent and longer than the head; temple narrower than the eye in dorsal view and bulging posteriorly; galea short.

THORAX: Lateral face of pronotum rugose on posterior half; median lobe of mesoscutum plain; notaulices distinct and foveolate; mesopleuron smooth and shining, upper groove weakly foveolate, lower groove foveolate and its lower margin flattened, posterior groove foveolate with a smooth depression at the middle anteriorly; metapleuron rugose, median ventral part of its anterior portion smooth and shining, and the posterior margin of its posterior portion flaring; propodeum rugose, pleural carina high and distinct, areola long, flat and indistinct, spiracular area acute posteriorly, spiracle long ovate. First abscissa of radius longer and thicker than that of basal vein; second abscissa of radius slightly less than three times as long as first; third abscissa of cubitus longer than fourth; second abscissa of cubitus shorter than recurrent vein (Fig. 3); interanal vein absent. Second and fifth segments of fore tarsus about equal; inner spur of middle tarsus about as long as basitarsus, second and fifth tarsal segments about equal; hind tibia flattened and broadened apically, tibial spur about as long as the second to fifth tarsal

[1] Received March 3, 1945.
[2] Journ. Straits Branch Roy. Asiat. Soc., no. 80: 57–58, fig. 3, ♀. 1919.

segments combined, basitarsus long, broad, and flattened, about two thirds as long as the tibia, the remaining four tarsal segments combined about three-fourths as long as the basitarsus, second tarsal segment thickened, longer than the fifth and apically joined to the basitarsus (Fig. 7); hind tarsal claws pectinate basally.

ABDOMEN: First abdominal suture extending obliquely forward from the sides of the median elevation of first tergite; second and third tergites medially of about equal length; hypopygium about as long as the third tergite, obtuse in profile; ovipositor sheath inconspicuous, pubescent, about half as long as the hypopygium.

Type.—Female, Iligan, Mindanao, Philippine Islands, C. F. Baker, U.S.N.M. no. 57270. This species is named in honor of Dr. E. A. Chapin, curator of insects, U. S. National Museum.

Laminitarsus rudis, n. sp.

Female.—Length 6.5 mm. Yellowish brown, the following parts black: Antenna except scape lateroanteriorly and pedicle apically, a transverse band taking in posterior part of vertex and upper part of occiput, ocellar area, frons medially, three broad longitudinal vittae on mesoscutum, mesopleuron except dorsal third, pectus, middle trochanters apically, middle tibia basally, middle tarsus except base, one spot on hind coxa dorsoapically, hind trochanters, hind femur basally, hind tarsus except base, and a transverse band on each tergite from third to seventh. Apex of hind tibia, and hind tibial spurs infuscated; wings hyaline and veins dark, forewing with apical fifth, and hind wing apically, light fuliginous.

HEAD: Antenna incomplete; scape and pedicle with pubescence about as long as the flagellum; eye bare; ocelli slightly elevated, the distance between the posterior pair about twice as long as that between either one of these and the anterior ocellus; vertex punctate and shining; occiput excavated; frons punctate, shining, with a low median longitudinal carina; face rugose, with a short median ridge at about upper third; clypeus punctate, not notched medially on apical margin; temple and eye about equal in dorsal view; maxillary palpus prominent, about as long as the head; galea short.

THORAX: Lateral face of pronotum rugose on posterior half; mesoscutum punctate, its median lobe plain; notaulices distinct, foveolate, and flat in the posterior angle; mesoscutellum punctate; upper groove of mesopleuron finely rugose, lower groove broad, punctate and flat on ventral part, and posterior groove foveolate with a smooth groove at the middle leading anteriorly to the lower groove; metapleuron rugose, its posterior margin flaring; propodeum rugose, its pleural carina high and distinct, its aerolar carina represented by a short stump posteriorly, its spiracular carina not distinct, and its spiracle long ovate. First abscissa of radius equal to that of basal vein but thicker, and about one-fourth as long as the second abscissa of radius; third abscissa of cubitus longer than the fourth; second abscissa of cubitus and recurrent vein equal (Fig. 4); interanal vein absent. Second and fifth segments of fore tarsus about equal; inner spur of middle tibia slightly shorter than the basitarsus and second and fifth tarsal segments about equal; hind tibia flattened and broadened toward apex, its inner spur longer than the second to fifth tarsal segments combined; basitarsus enormously developed, broadened, flattened, and slightly more than two-thirds as long as the tibia; the other four tarsal segments combined about half as long as the basitarsus, second and fifth segments about equal; hind tarsal claws pectinate basally.

ABDOMEN: First abdominal suture extending obliquely forward at the sides; second and third tergites of about equal length medially; hypopygium about as long as the third tergite and obtuse in profile; ovipositor sheath inconspicuous, about half as long as the hypopygium, and pubescent.

Type.—Female, Island of Basilan, Philippine Islands, C. F. Baker, U.S.N.M., no. 57271.

Laminitarsus singaporensis, n. sp.

Female.—Length 5 mm. Head and thorax yellowish brown; antenna, occiput, vertex, face medially, tip of mandible, lower half of proepisternum, mesopleuron, pectus, and anterior portion of metapleuron black. Mesoscutum black with anterolateral vitta of median lobe, and anterior end and a narrow vitta of lateral lobe laterad of the posterior half of the notaulix yellowish brown. Wings hyaline, apical fifth of forewing and tip of hind wing infumated. Legs yellowish brown, middle leg with

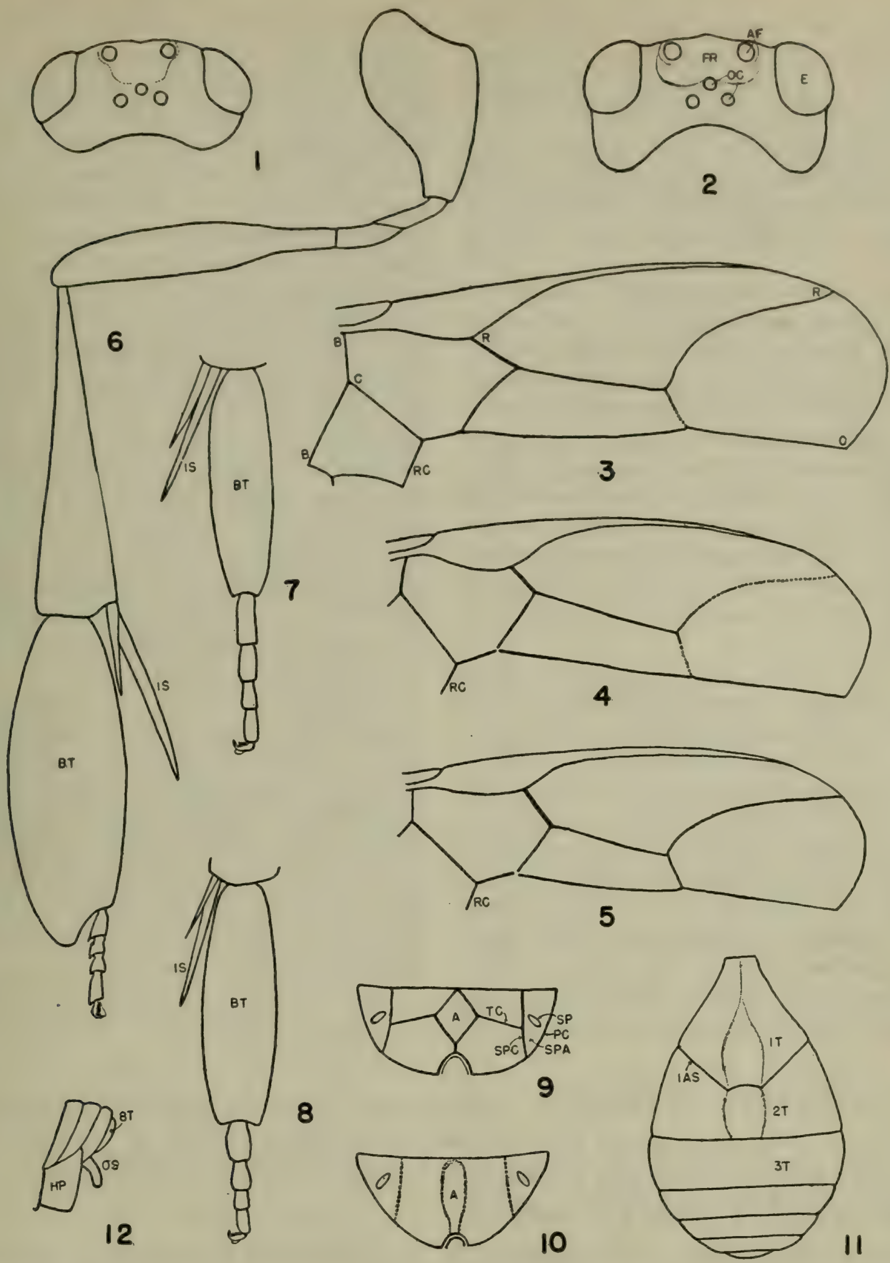

FIG. 1.—Head of *singaporensis* (dorsal view). FIG. 2.—Head of *chapini* (dorsal view) (similar to *rudis*). FIG. 3.—Part of forewing of *chapini* showing radius and cubitus. FIG. 4.—Part of forewing of *rudis* showing radius and cubitus. FIG. 5.—Part of forewing of *singaporensis* showing radius and cubitus. FIG. 6.—Left hind leg of *singaporensis* (ventral view). FIG. 7.—Part of hind leg of *chapini* showing tibial spurs and tarsus. FIG. 8.—Part of hind leg of *rudis* showing tibial spurs and tarsus. FIG. 9.—Typical propodeum of *Cardiochiles* Nees. FIG. 10.—Propodeum of *Laminitarsus* Fullaway. FIG. 11.—Abdomen of *singaporensis* (dorsal view) (similar to *chapini* and *rudis*). FIG. 12.—Part of abdomen of *singaporensis* showing hypopygium and ovipositor sheath (similar to *chapini* and *rudis*).

All figures are proportionally drawn. A, areola; AF, antennal foramen; B-B, basal vein; BT, basitarsus; C-C, cubitus; E, eye; FR, frons; HP, hypopygium; IS, inner spur; OC, ocelli; OS, ovipositor sheath; PC, pleural carina; RC, recurrent vein; R-R, radius; SP, spiracle; SPA, spiracular area; SPC, spiracular carina; ST, stigma; TC, transverse carina; IAS, first abdominal suture; 1T, first tergite; 2T, second tergite; 3T, third tergite; 8T, eighth tergite.

basal half of trochanter, femur apically, tibia basally and apically, tibial spurs, and tarsus, and hind leg with coxa medially, trochanters, apical two-thirds of femur, tibia basally and medially, apical oblique half of basitarsus, and last two tarsal segments black. Abdomen black, first tergite, the second medially and anteriorly, the third, and venter except apex yellowish brown.

Head: Antenna 48-segmented; scape and pedicel shining and with longer pubescence than the flagellum; eye bare; ocelli elevated slightly, arranged in a flat triangle, the anterior member smaller than the lateral ones (Fig. 1); vertex wrinkled, punctate, shining, and slightly sloping towards frons; frons impressed, wrinkled, and with a distinct median longitudinal elevation; face rough, with a median, narrow triangular extension above; clypeus rugose, apical margin not notched medially; temple not bulging, narrower than the eye in dorsal view; galea short.

Thorax: Lateral face of pronotum rather plain; notaulices distinct, narrow, and finely foveolate; mesoscutum punctate; median lobe of mesoscutum plain without a longitudinal depression along each side of the median line; transverse fossa with five septa; mesopleuron punctate, upper groove flat and indistinct, lower groove oblique across the middle of mesopleuron, and posterior groove narrow and finely foveolate; metapleuron rather plain; propodeum flat and plain (Fig. 10), pleural carina distinct, areola elongate, flat and indistinct, transverse carina absent, spiracular carina very low, spiracular area acute posteriorly, and spiracle long ovate, directed obliquely in the center of the spiracular area. Wings with thin veins; stigma somewhat lanceolate; first abscissa of radius longer than that of the basal vein; the second abscissa about 2.5 times as long as the first; third and fourth abscissae of cubitus about equal; second abscissa of cubitus longer than the recurrent vein (Fig. 5); nervulus postfurcal by half of its own length; interanal vein absent. Tibia of middleleg thin, inner spur about as long as basitarsus; second and fifth tarsal segments about equal. Coxa of hind leg prominent; femur thin; tibia flattened, broadened toward apex, and with a smooth depression at the upper apical end; inner spur of tibia long, slightly over half as long as the basitarsus; hind basitarsus enormously developed, flattened, about as long as the hind tibia, and joined by the second tarsal segments ventrally at apex (Fig. 6); second tarsal segment slightly shorter than the fifth; hind tarsal claws pectinate basally.

Abdomen (Figs. 11, 12): Shorter than thorax; first tergite slightly longer than the second and third combined; first abdominal suture extending obliquely forward at the sides; second tergite slightly longer than the third medially; hypopygium about as long as the fourth and fifth segments of middle tarsus combined, obtuse in profile, and not nearly attaining apex of abdomen; ovipositor sheath very short, subexserted, and pubescent.

Type.—Female, Singapore, C. F. Baker, U.S.N.M., no. 57272.

PARASITOLOGY.—*Localization of radioactive antimony following multiple daily injections to a dog infected with* Dirofilaria immitis.[1]

Dean B. Cowie, Alfred H. Lawton, A. T. Ness, Frederick J. Brady, and Glen E. Ogden.[2] (Communicated by John A. Fleming.)

Antimony compounds have appeared to offer the most promise in the treatment of human filarid infections. In our studies it was found (1) that daily injections of several such compounds were effective in eradicating microfilariae of *Dirofilaria immitis* from naturally infected dogs. With regard to the fate of antimony in the tissues, we have reported (2) the distribution of radioactive antimony following a single intravenous administration of tartar emetic, sodium antimonyl xylitol, and an aqueous suspension of antimony trioxide. Since multiple daily injections of compounds at the dosage level of 0.8 milligram of antimony per kilogram of body weight were used in the experimental treatments, a knowledge

[1] Received March 16, 1945.

[2] From the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and the Laboratories of Zoology, Chemistry, and Industrial Hygiene Research, National Institute of Health.

of the fate of the antimony after multiple injections was desired. In this paper a study with repeated injections of sodium antimonyl xylitol prepared from radioactive antimony is reported.

EXPERIMENTAL PROCEDURE

Radioactive antimony was prepared by the bombardment of antimony with deuterons in the cyclotron of the Carnegie Institution of Washington. The radioactive antimony was chemically separated from the other elements of the target and was recovered as nearly pure antimony trioxide. This was then synthesized into sodium antimonyl xylitol by the method described elsewhere (1). An aqueous solution of this chemical containing 10 milligrams of antimony per milliliter of solution was used throughout the experiment.

Dog no. 148 naturally infected with *Dirofilaria immitis* was given intravenously 0.8 milligram of antimony per kilogram of body weight as sodium antimonyl xylitol solution daily, except Sunday, for two weeks or a total of 12 injections. Blood samples were drawn immediately before each injection, 15 minutes after each injection, and 36 hours following the last injection. To these blood samples dry sodium citrate was added in the proportion of 10 milligrams per milliliter. Thirty-six hours after the last injection the dog was sacrificed and samples of 35 tissues were removed. The blood samples and the tissue specimens were weighed quickly after their removal, placed in a desiccator containing phosphorus pentoxide, and kept under reduced pressure at room temperature by means of a vacuum pump. After 16 hours of drying, tissues were reweighed and the amount of weight loss was determined. The samples were then ground in a mortar to a more or less homogeneous state.

Determinations of the antimony content of the blood and other tissues were made by measuring the number of disintegrations per second per unit weight of tissue powder with a Geiger-Müller counter and comparing this with a known standard. The standards were prepared by adding a known amount of the radioactive antimony to a sample of normal blood which

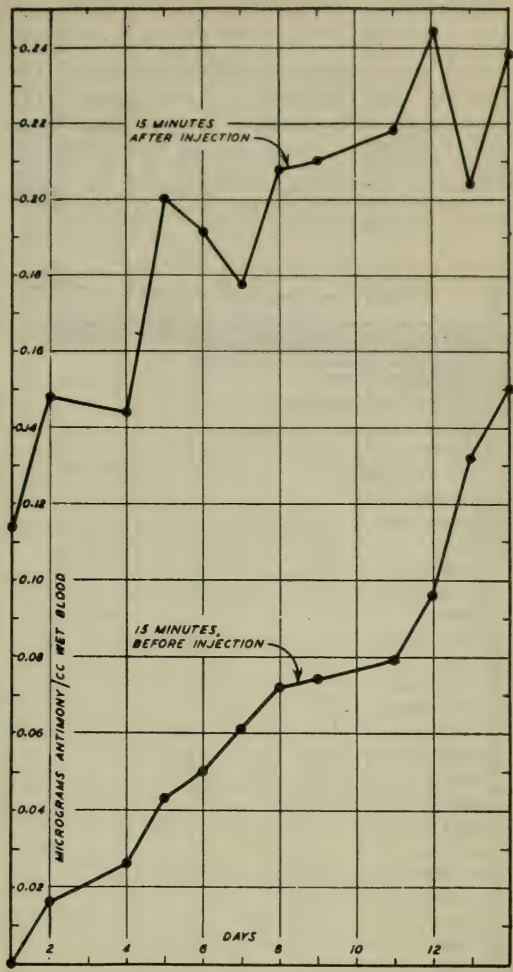

FIG. 1.—Antimony concentration in blood of dog no. 148, 15 minutes before and after injection.

was subsequently treated in the same manner as the samples containing the unknown quantities. An overall accuracy in these determinations of ± 1 per cent was demonstrated.

Microfilarial counts were made daily by a previously described method (3).

RESULTS

Figure 1 shows the blood content of antimony before each injection and 15 minutes after each injection. The antimony content is expressed in micrograms per gram of wet weight of blood. It will be noted that each injection causes the 15-minute postinjection level to exceed the previous

15-minute level, and the residual antimony in the blood at the end of each 24-hour period after injection remained above the previous residual level. An average of 0.112 microgram of antimony was cleared from each milliliter of the blood in 24 hours. With the cessation of treatment the antimony rapidly left the blood stream.

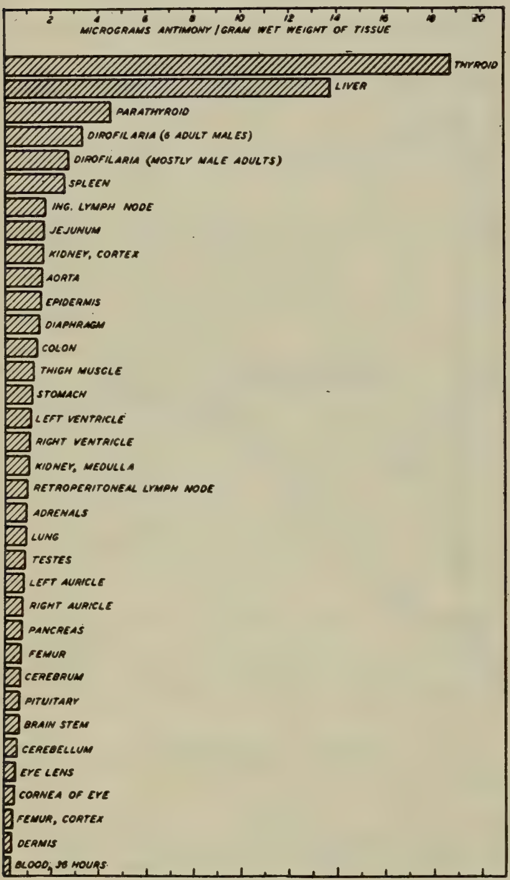

FIG. 2.—Antimony concentration in tissues of dog no. 148, 36 hours after last injection.

The dog in question became free of microfilariae after nine injections given over a 10-day period. Six live adult male *Dirofilaria immitis* were found in the right ventricle at autopsy. No live female parasites were recovered, but numerous fragments of recently dead and degenerated worms were removed from the pulmonary arterial tree. No other abnormalities were observed.

The antimony concentration of 35 tissues taken from this dog (no. 148) at autopsy 36 hours after the last treatment is given in Fig. 2 as micrograms per gram of wet weight of tissue. A wide variation in concentration values was recorded for the various tissues, ranging from 18.72 to 0.29 micrograms per gram of tissue. The thyroid gland had the greatest concentration of antimony. The liver also had a high antimony concentration, since each gram contained 13.75 micrograms. The parathyroid glands with 4.49, the filarids with 3.28, and the spleen with 2.60 micrograms of antimony per gram of wet weight were all higher than the highest blood level recorded in this experiment. It may be assumed that these tissues have a specific affinity for antimony. The other tissues are listed in the figure in the order of their antimony concentration.

DISCUSSION

In a previous paper (2) determination of the antimony in the blood after a single injection of tartar emetic and sodium antimonyl xylitol showed that there was an initial rapid decrease of the element during the first hour after injection followed by a slow removal for the next 4 to 16 hours with a slight secondary rise in the blood level at 24 to 36 hours. Of even more importance is the fact that the present experiment demonstrates continuous accumulation of the antimony in the blood. Parallel rates of accumulation are seen both 15 minutes and 24 hours after the injections. This shows that the repeated injection of 0.8 milligram of antimony per kilogram of body weight results in an accumulation of the element in the blood and that this dosage exceeds the clearance rate. Such a result adds support to the hypothesis (1) that a certain threshold of antimony must be reached before beneficial therapeutic results can be obtained. During the 24 hours preceding the elimination of circulating microfilariae, the highest recorded blood concentration was 0.218 microgram and the lowest was 0.096 microgram per gram of blood.

The irregularity of the curve showing the antimony level of the blood samples 15 minutes after treatment can be explained

on the basis that the rate of change was so rapid that an error of a minute or two in drawing the blood was reflected in the considerable change in the antimony level. In the case of the specimens taken 24 hours after the injection a time error of a minute or two made little difference in the results.

After single injections of tartar emetic, sodium antimonyl xylitol, or antimony trioxide, the liver contained the largest concentration of antimony. The thyroid and parathyroid tissues contained the next largest concentration and the adult *Dirofilaria immitis* ranked third. After 12 injections of sodium antimonyl xylitol, at the same dosage level as with the single injections, the thyroid gland contained the highest concentration of antimony, the liver was now second in antimony concentration, and the adult filarids remained third. A possible explanation for this reversal of the relative ranking of the thyroid gland and the liver is that the thyroid may continue its specific uptake of antimony whereas the liver may reach a point of equilibrium more quickly and the uptake and discharge of the antimony from the hepatic tissue may become equalized. In this way the thyroid gland finally exceeded the liver in the amount of antimony contained per gram of wet tissue.

There was an accumulation of antimony in all of the tissues studied and such tissues contained more antimony per gram of wet weight following multiple daily injections than they did following a single injection.

The finding of an element that is not known to enter into normal metabolic processes, such as antimony, in large quantities, in the thyroid gland was unexpected. These studies are being broadened so as to determine the relationship of this finding to the toxicology and therapeutic usefulness of antimony and other therapeutically active elements. This specific activity of the thyroid gland forms a broad basis for further studies in general physiology and pharmacology.

SUMMARY AND CONCLUSIONS

Twelve intravenous injections of sodium antimonyl xylitol in the amount of 0.8 milligram of antimony per kilogram of body weight daily, except Sunday, led to a continuous rise in the antimony level of the blood. The tissue levels of antimony were higher than those recorded following a single injection of this compound.

With the multiple injections of sodium antimonyl xylitol, the thyroid gland was found to contain the most antimony per unit weight and was followed in antimony concentration by the liver and the adult *Dirofilaria immitis.* Thirty-two other tissues showed a relatively small concentration of antimony, which was probably not of significance from a therapeutic standpoint.

It is believed that the observed accumulation phenomena offer evidence that a certain threshold of antimony must be reached before microfilariae of *Dirofilaria immitis* disappear from the peripheral circulation of infected dogs. It seems probable that a similar conclusion may apply in other helminth infections in which antimony is of value.

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(3) BRADY, FREDERICK J., and LAWTON, ALFRED H. *A new method for quantitative estimation of microfilariae in blood samples.* Journ. Parasitology **30** (1): 34. Feb. 1944.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

618TH MEETING

The 618th meeting of the Society was held at the Cosmos Club, January 12, 1944, President GEORGE TUNELL presiding.

Informal communications.—W. T. SCHALLER reported the discovery of a new mineral, a hydrous potassium calcium silicate, which he named miserite.

Program.—MARIE L. LINDBERG: *Heavy mineral correlation of the Fox Hills, Hell Creek, and Cannonball sediments, North Dakota.* A study of sediments along the Cannonball and Missouri Rivers, N. Dak., was made to correlate exposures of Fox Hills, Hell Creek, and Cannonball formations. Nine heavy mineral zones were established. In the Fox Hills formation, three heavy mineral zones correspond to three lithologic units: Zone 1, a thick-bedded yellowish-brown sandstone is characterized by an average amphibole content of 41 percent of the nonopaque heavy minerals; zone 2, an olive-colored sandy, banded shale contains 22 percent amphibole; zone 3, a gray-white sandstone increases in amphibole content to 66 percent. Zone 3 extends to the base of the Breien marine member of the Hell Creek. Zones 4 through 8 belong to the Hell Creek formation. Along the Missouri River, zone 4 is below the first bentonitic bed; zones 6 and 7 are superimposed. In the Cannonball River sections, zone 4, a fine-grained, badly weathered sand, is the lowest bed in the Breien; zone 6, a fine-grained to silty, grey-green sand begins in the Breien and extends into continental Hell Creek. Zones 5 and 8 are local. Zone 7 extends through upper Hell Creek to the top of the Ludlow. In zone 4, the amphibole content is 21 percent; epidote is 38 percent; and garnet is 16 percent. In zone 6 the amphiboles decrease to 7 percent; epidote is 40 percent; garnet is 23 percent. In zone 7 amphiboles are 4 percent; epidote increases to 51 percent; and garnet decreases to 15 percent. There is a marked change in heavy mineral content at the base of the Cannonball. Amphiboles increase to 55 percent in zone 9.

J. S. WILLIAMS: *Principal fluorspar deposits of the United States.*

J. B. MERTIE: *Piezoelectricity, with special reference to quartz.*

619TH MEETING

The 619th meeting of the Society was held at the Cosmos Club, February 9, 1944, President GEORGE TUNELL presiding.

Program.—G. D. ROBINSON: *The molybdenite deposit at Shakan, Alaska.* The molybdenite deposit near Shakan on Kosciusko Island, southeastern Alaska, is in a narrow, low-dipping fault zone, constituting a composite vein, in hornblende diorite. Breccia blocks of hornblende diorite are the principal vein filling. The diorite fragments are separated and locally replaced along the margins by bands and small irregular masses of igneous and hydrothermal materials, introduced at various times during repeated reopenings of the fault zone, and by silicified gouge. Included in the introduced matrix are granite pegmatite; quartz-adularia, quartz, and calcite veins; lamprophyre and aplite dikes; zeolite encrustations; and pyrite, pyrrhotite, chalcopyrite, sphalerite, and molybdenite.

Inconclusive evidence indicates that the distribution of molybdenite was controlled principally by openings developed in the steeper dipping parts of the fault zone as a consequence of small-scale normal faulting.

Surface and underground workings expose one ore shoot of moderate tonnage containing about 1.5 percent MoS_2. Additional ore shoots may be present in other relatively steep dipping parts of the zone not now exposed.

The introduced vein materials appear to have been deposited over a wide range of temperature but at relatively low pressure. Molybdenite was deposited near the end of the mineralization sequence. The deposit does not fit readily into the Lindgren classification; it is perhaps best grouped with the zenothermal type of Buddington.

W. H. HASS: *Conodont morphology.* Spectrographic and petrographic data on conodonts obtained through a study of collections from two Ordovician, seven Mississippian, and two Pennsylvanian formations permitted the following conclusions: (a) the conodonts studied are composed of a fluorian dahllite, a member of the dahllite-francolite isomorphous series of apatite minerals; (b) each lamella of a conodont is composed of innumerable dahllite crystals; and (c) the *c*-axis of each dahllite crystal

is invariably oriented in the direction in which the main ontogenetic growth occurred at the place in the lamella where the crystal is located. The data will be described and published in an article entitled *Orientation of the crystal units of conodonts*, by Wilbert H. Hass and Marie L. Lindberg.

P. B. King: *Tectonics of northeasternmost Tennessee.* The three northeasternmost Tennessee counties lie in the Appalachian province. Their rocks are strongly deformed, and the area is outstanding for its display of large-scale overthrusting in the pre-Cambrian, Cambrian, and Ordovician rocks.

This paper is an outgrowth of recent investigations of manganese deposits of the area. Part of the investigation consists of mapping extensive areas, one product of which was a reasonably comprehensive new picture of the structural features of the region.

This newer picture resembles that presented by Keith in folios of the Geological Survey, but there are modifications of the details. Movement along the Iron Mountain fault, which dips northwest, was interpreted in the folios as having been to the southeastward. However, distribution of rock facies, the nature of minor structural features, and other evidence indicates that the movement was actually northwestward. This implies much greater movement of thrust sheets to the northwest than was originally believed. The rocks to the northwest and above the Iron Mountain fault are now interpreted as belonging to the Shady Valley thrust sheet, and the rocks to the southeast and below it as belonging to the Mountain City window. Resting on the Shady Valley thrust sheet, as first recognized by Keith, is the still higher Bald Mountain thrust sheet.

The pattern of the overthrust faults is complicated by many tear faults, some of great length and displacement, which had not been recognized before the present investigation.

620th meeting

The 620th meeting of the Society was held at the Cosmos Club, March 8, 1944, President George Tunell presiding.

Program—L. A. Warner: *Magnetite deposits of Kasaan Peninsula, southeastern Alaska.* High-grade deposits of magnetite, containing some copper, on Kasaan Peninsula, Prince of Wales Island, southeastern Alaska, lie within a mile of salt water at altitudes of less than 1,500 feet.

The deposits have been worked intermittently since 1900, principally for their copper content, and have yielded more than 600,000 tons of ore valued at more than $6,000,000.

The ore consists chiefly of magnetite with pyrite and chalcopyrite. The ratio of chalcopyrite to magnetite ranges widely, and locally the deposits are chiefly copper ore with minor amounts of precious metals. The major reserves, however, are in iron ore and in the bodies examined the reserves are estimated to exceed 5,000,000 tons. The average ore tenor is about 50 percent iron and 0.5 percent copper. Phosphorus and titanium are virtually absent. The sulphur content ranges from a few hundredths of a percent to about 4 percent.

In 1942 the Geological Survey resumed a systematic study of the deposits which is still in progress. Topographic, magnetic, and geologic surveys have been made at most of the deposits which have been mined or prospected.

Some trenching, sampling, and diamond drilling have been carried on by the Bureau of Mines. Much of the peninsula has been only superficially prospected and it is anticipated that further work will reveal additional ore bodies.

R. H. Jahns: *The Harding beryllium-tantalum-lithium pegmatites, Taos County, N. Mex.*

W. T. Thom, Jr.: *The structural evolution of the Big Horn Basin.*

621st meeting

The 621st meeting of the Society was held at the Cosmos Club, March 22, 1944, President George Tunell presiding.

Informal communications.—L. Henbest discussed the lighting of specimens for photography.

Program.—W. M. Cady: *Stratigraphy and structure of west-central Vermont.*

G. T. Faust and E. Callaghan: *Mineralogy and petrology of the Currant Creek magnesite district, Nevada.*

W. H. Bradley, K. E. Lohman, and A. H. Frazier: *A machine for obtaining true perspective diagrams from maps.*

622d meeting

The 622d meeting of the Society was held at the Cosmos Club, April 12, 1944, President George Tunell presiding.

Program.—V. T. ALLEN: *Sedimentary and volcanic processes in the formation of high-alumina clays.* Along the Pacific coast, where volcanic materials predominate, the importance of sedimentary processes in the formation of high-alumina clays has not been fully appreciated. At Ione, Calif., Castle Rock, Wash., Whiteware, Mont., Hobart Butte and Molalla, Oreg., where the Geological Survey has been investigating clays jointly with the U. S. Bureau of Mines, sedimentary processes have been more important in the formation of high-alumina clays than have volcanic processes. Clays derived directly from volcanic materials are composed dominantly of montmorillonite; but these clays, with the exception of the beidellite-nontronite varieties, have relatively low percentages of available alumina. In contrast, clays derived by thorough leaching of various aluminous rocks under conditions favoring thorough drainage are composed dominantly of kaolinite and when sorted by sedimentary processes form high-grade deposits; furthermore, the depositional structures of these sedimentary clays have favored the derivation of gibbsite through weathering or the formation of dickite or kaolinite through hydrothermal action. Kaolinite, gibbsite, and dickite all have relatively high percentages of available alumina. The iron-bearing minerals in these deposits, arranged in the order of their importance, include: siderite, hematite, limonite, nontronite, pyrite, ilmenite, vivianite, celadonite, and scorodite.

S. E. CLABAUGH: *Paragenesis of the tungsten ore of the Ima mine, Idaho.* The Ima mine in the Blue Wing district is the second most important producer of tungsten in Idaho, and the quartz veins of the district constitute the largest of the known huebnerite deposits of the Western States. Workings of the Ima mine extend from Patterson Canyon northwestward for a distance of about half a mile, and the extent of the Ima vein system is presumably much greater. The productive veins occupy normal faults of small displacement in quartzite and granite. The quartzite is metamorphosed impure sandstone considered to be part of the Belt series. Granite is exposed only in the underground workings.

Closely associated with the granite are irregular bodies of pegmatite and orthoclase-bearing veins which contain mica, pyrite, and molybdenite. The pegmatite and feldspar-bearing veins are cut by the more persistent main veins which contain the economically important tungsten, silver, copper, and lead minerals.

Most of the ore shows prominent banding which is attributed to repeated fracturing or reopening of the veins during mineralization. Unbanded parts of the vein material near the granite contact contain large crystals of pyrite, fluorite, and huebnerite. Banded ore contains the same minerals plus rhodochrosite, tetrahedrite, sphalerite, galena, and chalcopyrite. The general sequence of minerals is as follows: orthoclase, quartz, and mica followed by pyrite and molybdenite in the early veins; quartz, fluorite, pyrite, and huebnerite in the unbanded ore, followed by quartz, rhodochrosite, huebnerite, sphalerite, and finally quartz, fluorite, tetrahedrite, galena, and chalcopyrite in the banded. Scheelite occurs in small seams along fractures and replaces shattered huebnerite.

J. D. H. DONNAY: *Twinning, isomorphism, and epitaxy.*

623D MEETING

The 623d meeting of the Society was held at the Cosmos Club, November 8, 1944, President GEORGE TUNELL presiding.

A memorial to E. O. ULRICH was read before the Society by J. B. REESIDE, JR. (Published in this JOURNAL **34** (5): 168. 1944.)

A memorial to ARTHUR KEITH was spoken by N. H. DARTON. (Published in this JOURNAL **34** (7): 240. 1944.)

A memorial to GEORGE STEIGER was read by J. J. FAHEY. (Published in this JOURNAL **34** (10): 347. 1944.)

A memorial to ROGER C. WELLS was read by W. T. Schaller. (Published in this JOURNAL **34** (10): 348. 1944.)

Program.—H. R. GAULT: *Geology and zinc deposits in the Groundhog and Glacier Basins, Wrangell district, southeastern Alaska.* Groundhog and Glacier Basins are on the mainland of southeastern Alaska about 13 miles east of Wrangell.

The zinc deposits are in a sequence of schists and gneisses which are part of a belt of metamorphic rocks bordering the west side of the Coast Range batholith for many miles. The schists and gneisses in Groundhog and Glacier Basins are bounded on the west by a large sill-like mass of quartz diorite.

Bedding and cleavage of the metamorphic rocks are about parallel. The regional strike is N. 25° W. and the general dip is 60° N.E.

Many quartz porphyry sills and dikes cut the metamorphic rocks and the sill-like quartz diorite. Quartz-fluorite breccia veins occupy many faults and fractures and are younger than the quartz porphyry sills. Basalt sills and dikes are widespread and are younger than the veins.

Breccias, made up of fragments of metamorphic rocks and quartz porphyry, occur as sills and dikes and as large irregular masses in the metamorphic rocks.

The zinc deposits are pyroxene granulite beds that have been replaced by sphalerite, galena, and pyrrhotite and minor amounts of other sulfide minerals. Two types of ore are recognized, a solid-sulphide type and a disseminated-sulphide type. Significant amounts of ore of the solid-sulphide type crop out only in Groundhog Basin. Ore beds containing only disseminated ore crop out on the north slope of Glacier Basin and at higher altitudes to the north toward Groundhog Basin grade into and are interbedded with barren pyroxene gneiss.

The most westerly ore bed in Glacier Basin is correlated with the lowest bed in Groundhog Basin.

The total known extent of zinc metallization in the pyroxene granulite beds is about three miles through a vertical range of about 3,000 feet. The best ore in both basins is exposed at the lowest altitudes. In a general way the best metallized portions in both basins also occur in those parts of the ore beds which are nearest the sill-like quartz diorite.

H. J. Yagoda: *Localization of chemical constituents by chemical patterns.* A review of printing methods applicable to the study of mineral constituents in polished massive or thin sections. Among the techniques covered are included luminescent phenomena (fluorescence, phosphorescence, and thermoluminescence), autoradiography, electrographic and contact printing.

Material not previously published includes a method for recording an autoluminographic pattern by contacting the phosphorescing specimen against color sensitive film. The use of fine-grained alpha-ray emulsions is described as a means of recording the distribution of uranium and thorium minerals in the polished surface. These emulsions provide a highly selective medium for obtaining a sharply defined autoradiographic pattern, capable of quantitative interpretation and which permits the resolution of fine detail.

A modified contact printing procedure is described which involves the etching of the surface by vapors and the transfer of the corrosion film to a transparent gelatin coating moistened with specific reagents. The characteristic colors serve to localize heavy metals in the polished section.

624th meeting

The 624th meeting of the Society was held at the Cosmos Club, December 13, 1944, Vice-president Frank Shairer presiding.

Program.—Presidential address by George Tunell: *Some thermodynamic and leptologic threads in the geologic tapestry.*

52d annual meeting

The 52d Annual Meeting was held immediately following the 624th regular meeting. The reports of the secretaries, treasurer, and auditing committee were read and approved. Officers for the year 1945 were then elected as follows: *President:* L. W. Currier; *Vice-presidents:* A. A. Baker, W. S. Burbank; *Secretary:* Margaret D. Foster; *Treasurer:* R. E. Stevens; *Council:* C. Milton, W. M. Cady, J. J. Glass, E. F. Osborn, Helen Duncan.

The Society nominated George Tunell to be a Vice-president of the Washington Academy of Sciences for the year 1945.

Obituaries

George Whiteley Coggeshall, a member of the Washington Academy of Sciences, died on November 19, 1944. He was born at Des Moines, Iowa, on December 21, 1867. He took his B.S. degree at Iowa College in 1890 and a Ph.D. degree in chemical engineering at Leipzig, Germany, in 1895. He attended the Harvard University Graduate School in 1891–92. In 1900 he married Anna Torrey, by whom he had three daughters. From 1895 to 1897 he served as chemistry instructor at Harvard University. In 1898 he organized the Eastern Chemical Co., Boston, and was president of it to 1910, when he moved to Washington, D. C., to become head of the chemical engineering division of the Institute of Industrial Research. In 1924 he accepted a position as head of the research laboratory with the S. D. Warren

Paper Co., Cumberland Mills, Maine, and was associated with that concern until his retirement.

Dr. Coggeshall was an inventor of concentrated fertilizers and several insecticides and fungicides. He developed processes for producing chemical compounds of titanium from rutile, processes for producing potash salts from silicate rocks, and gasoline from heavy petroleum oils. He also did much special work for clients. His publications included a thesis entitled *The constants of calomel electrodes*, and papers on the use of titanium salts in dyeing and mordanting, on the production of potash salts from feldspathic rocks, and on the treatment of the surfaces of concrete vessels. During World War I he was connected with the Section on Concrete Vessel Construction, U. S. Shipping Board. He was a member of the American Chemical Society, Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, and other scientific organizations. His clubs included the St. Botolph (Boston), Harvard and Chemists' Clubs (New York), and Cosmos and Chevy Chase Clubs (Washington, D. C.).

H. A. Gardner

Lyster Hoxie Dewey, retired botanist of the U. S. Department of Agriculture, died at Kenmore, N. Y., on November 27, 1944, after a long illness.

Mr. Dewey was born at Cambridge, Mich., on March 14, 1865, the son of Francis A. and Harriet (Smith) Dewey. He was educated in the public schools of Michigan, graduating from the high school at Tecumseh in 1885 and from the Michigan Agricultural College (now the Michigan State College) in 1888. He taught botany at the Michigan Agricultural College for two years, and in September 1890 he was appointed an assistant botanist in the U. S. Department of Agriculture. His earlier work in the department was with grasses and weeds, and from 1899 to the time of his retirement in 1935 he was in charge of investigation and research relating to plant fibers other than cotton.

The regions in which Mr. Dewey worked included many different countries. His major investigations in the United States were with flax and hemp, and his selections of these plants resulted in the development of improved strains, eliminating the necessity of importing seed of fiber flax from Europe, and hemp seed from China. In Puerto Rico he conducted experimental work with sisal, henequén, and other tropical fiber plants in cooperation with the Federal Agricultural Experiment Station at Mayagüez. In 1903 and again in 1907 he made field studies of the fiber plants of northern and central Mexico, and in 1911 he represented the U. S. Department of Agriculture at the World Fiber Congress held at Sourabaia, Java. Among the other countries which Mr. Dewey visited and in which he made fiber surveys were Cuba, the Bahama Islands, Algeria, Ceylon, the Federated Malay States, Japan, and the Hawaiian Islands. In all his investigational activities he was devoted to precise thinking and meticulous attention to accuracy. These qualities were evidenced by his long-continued effort to establish a correct and uniform nomenclature for the plant fibers. For many years before his retirement from active service Mr. Dewey was widely recognized both in scientific and industrial circles as the leading American authority on the plant fibers.

He was the author of numerous circulars, bulletins, and articles on grasses, weeds, and plant fibers. After his retirement at the age of 70, in 1935, he prepared the section on fiber plants published in *Standardized Plant Names*, and also a comprehensive series of articles which were published in Spanish by the Pan American Union in a pamphlet entitled *Fibras Vegetales y su Producción en América*, and by the U. S. Department of Agriculture in Miscellaneous Publication No. 518 entitled *Fiber Production in the Western Hemisphere.*

Mr. Dewey held membership in a number of professional organizations, including the Botanical Society of Washington, the Biological Society of Washington, the American Genetic Association, and the Washington Academy of Sciences. For more than 40 years he took an active part in the civic and religious activities of his community, and was a member of the Petworth Citizens Association. He was a member of the Gunton-Temple Memorial Presbyterian Church in Washington, and an elder in that church for 42 years, including 38 years as Clerk of Sessions.

In 1889 Mr. Dewey married Miss Etta Conkling, whom he survived. They had two children, Mary Genevieve, who died at the age of 17, and Grace Marguerite, who is now Mrs. Carl G. Frost, of Kenmore, N. Y.

Mr. Dewey will long be remembered as a man who always rang true. His outstanding qualities were modesty, kindness, devotion to duty, and sterling integrity, and his entire life was characterized by an unselfish desire to be of service and usefulness to others.

Harry T. Edwards.

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JOURNAL
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PHYSICS.—*The measurement of some thermal properties of water.*[1] H. F. STIMSON, National Bureau of Standards.

At the end of the eighteenth century it was shown that heat was not a substance but a form of energy. In a report in 1798 Count Rumford described an experiment, made while boring a cannon, where sufficient heat was developed with a blunt tool in two and one-half hours to raise the temperature of 26.5 pounds of cold water to its boiling point, although in doing so less than 0.6 of a pound of metal was removed. This evidence proved *almost* conclusively that heat was a form of energy. A more conclusive proof, however, was given in 1799 when Sir Humphry Davy described an experiment in which he melted ice by rubbing two blocks of it together.

Since it was shown that heat was a form of energy, it was rather natural that the unit of heat energy was defined at first in terms of the properties of water. The unit of heat was taken as the energy necessary to heat a unit mass of water 1°. In the metric system the units were the energy necessary to raise a gram, or a kilogram, of water 1°C. and were called the gram calorie, and kilogram calorie, respectively. In the English system the unit was the heat necessary to raise a pound of water 1°F. and was called the British thermal unit (BTU). The unit of heat defined in terms of water was very convenient because most calorimetric measurements were made in terms of the heat capacity of water, and also because the specific heat of water changes little with temperature. When the precision of measurement had increased, and it was shown that the specific heat of water did vary with temperature, it became necessary to define the heat unit more precisely. This led to the use of different calories, known as the 0° calorie, the 4°, 15°, 18°, 20° calorie and also the mean calorie, which was the mean between 0° and 100°C.

About 1830 Sadi Carnot had estimated the heat unit to be equivalent to 370 kilogram meters, which is about 13 percent lower than the present accepted value. Carnot had planned to determine the heat unit experimentally, but his early death in 1836 stopped these experiments.

James Prescott Joule (*1*)[2] appears to be the first to have made systematic measurements of the mechanical equivalent of heat. His experiments began about 1840 and continued up to 1878. He made these experiments with different substances to show that heat was a form of energy quite independent of the substance which was heated. The mechanical equivalent of heat, or Joule's equivalent, subsequently has been denoted by the letter "J." As a further tribute to Joule, all science now honors him by the use of his name for a unit of energy.

Henry A. Rowland (*2*), in his painstaking way, made experiments on the mechanical equivalent with an apparatus similar in design to Joule's but with Rowland's characteristic attention to detail. These experiments were made in the range from 5° to 35°C. in order to study the variation of the specific heat of water with temperature. At the conclusion of his paper, published in 1878, he modestly stated that "between the limits of 15° and 25°C., I feel almost certain that no subsequent experiments will change my values of the equivalent so much as two parts in 1,000." This modest claim seems to be fully substantiated by recent experiments.

[1] Address of the retiring president of the Philosophical Society of Washington, delivered at the 1242d meeting of the Society, January 6, 1945. Received February 26, 1945.

[2] Italic numbers in parenthesis refer to literature cited at the end of this paper.

A classical determination of the mechanical equivalent of the mean thermal unit between 0° and 100°C. was published in 1897 by Osborne Reynolds and W. H. Moorby (*3*). Reynolds was the engineer, famous for his researches on fluid motions, with whose name is associated the dimensionless numbers which describe the states of fluid flow. These men used power from a 65 horsepower steam engine for heating a continuous flow of water in a hydraulic brake of Reynolds's design.

This short list of researches on the mechanical equivalent of heat would be incomplete without mention of the relatively recent determination by Laby and Hercus (*4*), published in 1927. In their ingenious apparatus they made use of a flow calorimeter in which heat was produced by electric currents induced by a rotating electromagnet. The energy was measured mechanically by determining the couple in much the same way that Joule and Rowland measured it. This was done by refined methods which justify their claim to "the highest precision attainable with the present developments of physical technique." This research may well be the last classical experiment to determine the mechanical equivalent of heat *directly*, because the indirect method of measuring energy electrically not only is much more convenient but is also more accurate.

At present the ratio of the electric units of energy to the mechanical unit is known to a considerably greater accuracy than the ratio of the heat unit to the Joule. For this reason, present-day experiments in calorimetry are usually arranged to measure electric energy directly, as it is added to the calorimeter and its contents, rather than to determine the energy by exchanging heat with water. This development removes the need for a heat unit different from the mechanical unit but does not dispel interest in the thermal properties of water.

During the period when the accuracy of the electric units was increasing, however, some pioneers made measurements of the heat unit by supplying the energy to water electrically. Notable among these pioneers are Dieterici, Griffiths, and Schuster and Gammon.

These researches were followed by another, reported in 1902 by Callendar (*5*) and by Barnes (*6*), on measurements made with a continuous flow calorimeter "on the capacity for heat of water between the freezing and boiling points." These measurements of the heat caapcity of water were more comprehensive than any of the other measurements up to that time. In 1899 and 1900 Dr. Barnes, on 54 days, made measurements at mean temperatures ranging from 1.35° to 91.55°C. Four runs were usually made on each day at two rates of flow, one high rate and one low rate, in order to make corrections for the heat losses due to radiation and conduction. These rates were varied over a ratio of nearly 2 to 1, and the heat losses varied from a little over 1.5 percent for the large flow at the lowest temperature up to nearly 6 percent of the energy input for the small flow at the highest temperature. Dr. Barnes (*7*), in 1909, estimated an accuracy for his determinations of 1 part in 10,000 over the entire range, but recent measurements suggest the possibility of some unsuspected systematic errors in his results.

In 1921 Jaeger and von Steinwehr (*8*) reported on "the heat capacity of water between 5° and 50°C. in international watt seconds." They used an electric heating method at a time when the units and standards were much better known than when Barnes made his measurements. An accuracy of 1 part in 5,000 was claimed for the heat capacity of water at 15°C.

A new series of researches on the properties of water was planned at a conference (*9*) of engineers and physicists held in Cambridge, Mass., on June 23, 1921. This conference was sponsored by the American Society of Mechanical Engineers for the purpose of obtaining accurate data on the properties of water, which would form the basis of more reliable steam tables with which the engineers could design their turbines. Prof. Harvey N. Davis at Harvard University agreed to complete measurements he had started on the Joule-Thomson coefficient of steam. Prof. Frederick G. Keyes at the Massachusetts Institute of Technology (M.I.T.) undertook measurements on the pressure-volume-temperature

relations of steam. The first request to the National Bureau of Standards (N.B.S.) was to determine the mean heat unit.

The late Nathan S. Osborne accepted this responsibility but proposed to go much further by determining not only the heat of the liquid but also the heat of vaporization of water over a wide range of temperature. It is to him that the principal part of this discussion is dedicated. His genius and vision, coupled with his earlier experience in calorimetry, made the successful completion of this work possible. His experience had taught him not to go ahead blindly with the design of a calorimeter which would merely be a copy of previous calorimeters, but first to study the thermodynamics of the experiments that could be performed in the laboratory. This study proved to be a master stroke for it developed the principle of a systematic method of fluid calorimetry. The theory of this method was first published by Osborne (*10*) in April 1924 under the title of "Calorimetry of Saturated Fluids," where the term *saturated* restricts the calorimetry to experiments in which both liquid and vapor are always present.

The method makes use of a single calorimetric apparatus with which a system of measurements may be made to determine some of the essential thermal properties of a fluid, in particular the enthalpy $H = U + pv$ where U is the internal energy of the substance, p the pressure, and v the specific volume of the substance. The calorimeter is provided with two outlet tubes, one at the bottom for introducing or withdrawing liquid and the other at the top for withdrawing vapor. Valves are provided, on these tubes, for sealing fluid in the calorimeter and for controlling the rate at which fluids are withdrawn. The calorimeter is surrounded with an envelope the temperature of which is controlled to prevent any net exchange of heat with the calorimeter. All experiments are made with both liquid and vapor in the calorimeter when the properties of saturated fluids are being investigated.

The essentials of this method are as follows. First consider two experiments (*a*) and (*b*) with the same calorimeter, (*a*) with a large amount of liquid and some vapor to maintain the saturation state and (*b*) with a small amount of liquid. In these two experiments the calorimeter contains the masses of fluid M_a and M_b, respectively, and the quantities of energy Q_a and Q_b are found necessary to heat the calorimeter and its contents from the same initial temperature, t_1, to the same final temperature t_2. The difference of the energies, $Q_a - Q_b$, is used to heat the difference of the masses of the fluid contents, $M_a - M_b$, from one temperature to the other. The quotient of these differences would be equal to the change in enthalpy, H, of the liquid, were it not for the extra vapor in experiment (*b*). This requires a correction term $-L\dfrac{v}{v'-v}$ where L is the latent heat of vaporization and v and v' are the specific volumes of the saturated liquid and vapor respectively. This gives the equation:

$$\frac{Q_a - Q_b}{M_a - M_b} = \left[H - L\,\frac{v}{v'-v} \right]_{t_1}^{t_2} = \left[\alpha\right]_{t_1}^{t_2}.$$

The quantity $H - L\dfrac{v}{v'-v}$ in this equation is a specific energy function which Osborne called α. Notice that in getting α by the method of differences in the fillings, not only is the energy correction for the heat capacity of the empty calorimeter eliminated but also other energy corrections which are the same as long as both liquid and vapor are in the calorimeter. These α experiments are essentially liquid heat capacity experiments.

Now consider another type of experiment, which may be called a vaporization experiment, for getting the enthalpy of the saturated vapor. Consider a calorimeter nearly filled with liquid and let energy be supplied to evaporate liquid to vapor, most of which is withdrawu through a throttle valve at a rate so controlled as to keep the temperature of evaporation constant. The theory shows that the heat added, ΔQ, divided by the mass withdrawn, ΔM, is equal to the latent heat L plus the correction, $L\dfrac{v}{v'-v}\cdot$ This correction is the energy necessary to vaporize water to fill the space no

longer filled with liquid. This gives the equation:

$$\frac{\Delta Q}{\Delta M}=L+L\frac{v}{v'-v}=\gamma.$$

The right-hand member of this equation is also a specific energy function, which Osborne called γ.

Now consider a third type of experiment where liquid instead of vapor is withdrawn as heat is added. Here liquid is evaporated to fill the space which is emptied of water. This gives the equation:

$$\frac{\Delta Q}{\Delta M}=L\frac{v}{v'-v}=\beta.$$

This is the same quantity that appears as a correction term in the preceding equations for the heat of the liquid and the heat of vaporization. This function he called β.

These three functions, which can be determined experimentally, may be used to calculate the more familiar functions

$$H=\alpha+\beta$$

$$L=\gamma-\beta=H'-H$$

$$H'=H+L=\alpha+\gamma.$$

So far these derivations use only the first law of thermodynamics. If the second law with the Clapeyron relation is used, the following equations result:

$$\beta=L\frac{v}{v'-v}=vT\frac{dp}{dT}$$

$$\gamma=L+L\frac{v}{v'-v}=L\frac{v'}{v'-v}=v'T\frac{dp}{dT}$$

where T is the absolute temperature and p the vapor pressure. These relations give a way of comparing the calorimetric data with the volumetric data such as has been obtained at the M.I.T., provided the vapor pressure slope and the absolute temperature are known.

For water the α is nearly a linear function of temperature. The β is very small at the freezing point but increases progressively until the slope is infinite at the critical point. The γ is everywhere greater than the β by the latent heat L. At the critical temperature when L becomes zero the β and γ curves meet.

Both β and γ can be measured with the same absolute accuracy; hence measured values of β can be subtracted from measured values of γ to get L without loss of accuracy. The Clapeyron relation in the equations above, however, provides a method of computing β with greater accuracy when β is small, provided v and dp/dT are known with a moderate accuracy.

For the measurements of these properties, a calorimeter is used for containing a sample of water while its thermal behavior is observed. The thermal behavior is determined by three principal quantities that must be measured, namely:

1. Mass subjected to process.
2. Energy added to system.
3. Change of state produced.

The measurement of mass is relatively simple because the samples are sealed in tight containers with valves, and never opened to the outside when accounting for mass. The measurement of energy is not so simple, because no way has yet been found to make calorimeters quite tight for heat. The measurement of the change of state involves the measurement of changes in temperature or pressure.

The first calorimeter (*11*) for this work was made of a copper-nickel alloy, and was 3 inches in diameter, 6 inches high, with rounded ends. This calorimeter was silver-plated on the inside, to provide protection against contamination of the water, and on the outside, to present a bright surface to make radiation small. Small tubes at the top and bottom served both as supports for the calorimeter and as ducts for fluids. The tube at the bottom contained a hollow shaft for driving a centrifugal pump in the calorimeter which circulated a sheet of water over the entire inside wall for distribution of heat. This pump also supplied a flowing film of water over a sheathed heater which was covered with silver gauze. Here the electric energy was added to the calorimeter. The casings for circulating water were made of pure silver, the pump was made of gold-silver and silver-palladium alloy, and the

pump bearings were made with osmium-iridium balls and races.

The calorimeter was supported inside of a larger copper-nickel shell, called an envelope, which also was silver-plated on the inside. The space between these shells was evacuated during the experiments to make negligible the heat exchange by gaseous conduction and convection. The envelope was mounted in a circulating bath of oil whose temperature was controlled to keep the envelope temperature very close to the calorimeter temperature.

The thermometric installation on this calorimeter and its successors was novel and characteristic of Osborne's experimental methods. Temperatures were measured and controlled with a combination of platinum resistance thermometers and thermoelements mounted on a thick copper reference block directly above the envelope. The temperature of the reference block was determined accurately with resistance thermometers. The small temperature differences between this reference block and vital parts of the apparatus were determined by differential thermoelements having reference junctions on the reference block and principal junctions distributed at chosen places on the surface of the calorimeter and its envelope. These elements were used in groups to determine the small difference between the integrated surface temperature of the calorimeter and the temperature of the reference block. The elements on the calorimeter were opposed to the elements on the envelope so that the envelope temperature could be controlled close to that of the calorimeter in order to avoid any considerable heat exchange. The indications of these differential thermoelements were observed and recorded every minute during experiments, so that proper account could be made of the residual heat exchange with the envelope.

The water used in these experiments was taken from laboratory stills and then redistilled in a special still, which removed all but about 0.1 percent of the dissolved gases. The water was then stored and weighed in silver containers sealed with diaphragm valves before it was introduced into the calorimeter. These diaphragm valves were made entirely of metal and had no stuffing boxes. The masses introduced into the calorimeter ranged from about 275 grams up to nearly 500 grams.

The electric power, added to the calorimeter heater, was taken from storage batteries and measured with a five dial potentiometer, which determined both the current to the calorimeter and the potential drop across the leads. The power was then multiplied by the time to give the electric energy input. The circulating pump supplied less than 0.1 watt of power, but calorimetric determinations showed this power to be somewhat uncertain, and so it may have been one of the greater limitations to accurate accounting of energy in this calorimeter. These energies, together with the net energy added to the calorimeter by conduction and radiation, integrated over the period of the experiments by means of the differential thermoelement readings, made up the total energy input.

The α or heat-capacity experiments were made by first measuring the temperature of the calorimeter with the thermometers and thermoelements when the envelope temperature was adjusted and the circulating pump running. Power input was then started by means of a switch, which was activated by a spring but released by the signals from a Riefler clock. At the end of a predetermined time (usually 10 minutes), when sufficient energy had been added to raise the temperature of the calorimeter and its contents by the desired amount (usually 10°), the power was switched off by the same switch. During this heating period the envelope temperature was kept near the calorimeter temperature so that the net heat transfer would be small. In general a few minutes after the end of the period of heating, a satisfactory temperature equilibrium had been attained so that this temperature could be determined and another experiment started. This process was continued with both large and small masses in the calorimeter until 8 to 18 experiments had been made in each 10° temperature interval in successive steps over the entire range from about 1° up to 270°C. These measurements furnished the data for formulating α as a function of temperature.

The γ experiments were performed at 8 nominal temperatures, from 100° up to 270°C. In these experiments the envelope bath was thermostated to keep the temperature constant. As power was supplied by the heater, vapor was withdrawn through a throttle valve continuously controlled by the operator to maintain a constant temperature on the surface of the calorimeter. The vapor was first condensed in one of the silver containers until proper temperature and flow conditions were attained. A series of temperature readings was then taken, and midway in this series the flow was shifted to another container by opening and closing valves operated by a spring and released by signals from the clock. The durations of these experiments varied from ten minutes to an hour, and sometimes as many as eight experiments were made successively on one day. The rates of flow were varied from about half a gram per minute to 2 grams per minute for the purpose of detecting any systematic variation in the derived γ such as might be caused by the withdrawal of liquid droplets along with the vapor.

The β experiments were performed in a manner somewhat similar to the γ experiments, except that liquid was throttled out of the bottom of the calorimeter. Since it was desirable to remove most of the available liquid contents in one experiment the flow and power input were started and stopped, instead of being continuous as in the γ experiments.

All known corrections were applied to these measurements, and then adjustments were made to reduce the results to even temperatures for ease in formulating. When the formulation was completed a table was made which gave values of the enthalpies H and H', the latent heat L, and the entropy S and S', of both the saturated liquid and saturated vapor at each integral 10°C. from 0° to 270°C. This was published (*11*) in 1930, and the engineers proceeded to incorporate these results in steam tables.

The engineers by this time were eager to have information about the properties of water and steam at still higher temperatures because, in striving for higher efficiency, turbines were being made to run at higher pressures. The experiments up to 270°C. had proved the great value of Osborne's method of calorimetry for attaining accurate values of the enthalpy of saturated liquid and saturated vapor but certain features of the first calorimeter were inadequate for measurements at higher temperatures and pressures. Considerable difficulty had been experienced in maintaining constant temperature control with the oil bath at 270°C. Furthermore, the copper-nickel calorimeter was not strong enough to withstand a fourfold increase in pressure at a 100° increase in temperature. In addition, it was not considered feasible to make a pump shaft stuffing box which would hold four times the pressure because the erosion of the shaft had already been excessive at the higher pressures. Again there was a strong suspicion that the pump power was not a single valued function of the pump speed and that uncertainties in its power input existed.

In the meantime metallurgists had been developing new stainless steels, and so it was decided to make a new calorimeter of a stainless steel made of a chromium-nickel-tungsten alloy, which had the property of low creep at high temperatures. This calorimeter (*12*) was $2\frac{1}{2}$ inches in I.D. and $5\frac{1}{2}$ inches high with hemispherical ends. The wall was only an eighth of an inch thick, yet it was strong enough to hold the critical pressure of water of over 218 atmospheres. It was machined out of a solid bar of steel that had been compressed axially in a hydraulic press so as to give extra strength to the calorimeter by circumferential work-hardening. This calorimeter, like the first, was supported by tubes at the top and bottom for introducing and withdrawing fluid. The heater in this calorimeter was small and was concentrated near the bottom so that the energy would cause bubbles of vapor to form and rise near the axis of the calorimeter and hence cause some stirring to accelerate the distribution of heat. Heat was distributed also by conduction in 30 flat plates of 0.5 mm silver, which were mounted radially from the axis to the shell to provide good thermal connection throughout the calorimeter.

It was decided not to provide for evacuat-

ing the space around this calorimeter, partly because it simplified construction when highest precision was not demanded and partly because the proportionate saving in heat leak was not so great at the higher temperatures where radiation predominates. The isothermal envelope around this calorimeter was a shell of pure silver 4 inches O.D. and a quarter of an inch thick, with quarter-inch silver plates in the ends. This in turn was surrounded with a 5-inch O.D. pure silver shell one-eighth inch thick with end plates. Silver was used because it is the best conductor of heat and because it also has the lowest emissivity for radiation. The function of the inner silver shell was to present a controlled isothermal surface to the calorimeter. The function of the outer shell was to withstand the brunt of the envelope heat supply and to maintain its average temperature near the calorimeter temperature, while losing heat to the room. The outer silver shell was insulated with an inch of air partitioned with two thin concentric aluminum radiation envelopes. This was all contained in a heavy brass casing of sufficient strength to hold the contents of the calorimeter in the event of a rupture while in service. A heater on the outer silver shell constantly supplied heat to keep its temperature up to the calorimeter temperature. A heater on the inner shell was used only when the temperature was being raised such as in the α experiments.

The reference block in this apparatus was located above the calorimeter inside the heavy silver shell and was made of two pieces of silver $\frac{1}{4}$ by $1\frac{1}{2}$ by $2\frac{1}{4}$ inches held together horizontally and having a vertical hole in the center one-half inch in diameter for the vapor outlet tube. This block held two resistance thermometers and 31 thermoelement reference junctions. More junctions were used on this calorimeter than on the first calorimeter to compensate partly for the lack of stirring in the calorimeter and also for the lack of vacuum insulation around it.

It was decided to use the calorimeter first to measure the vapor pressure of water over the range from 100°C. up to the critical temperature. This decision was fortunate because the results of these measurements inspired Professor Keyes (*13*), at the Massachusetts Institute of Technology, to remeasure the vapor pressure of water. These two determinations were then in satisfactory accord with the similar determination just previously made in England by Prof. A. C. Egerton and G. S. Callendar (*14*), the latter being the son of the late Prof. Hugh Callendar, mentioned in connection with Barnes.

The principal accessories to the calorimeter that were needed for the measurements of vapor pressure were a pressure capsule and a precision pressure gauge. The pressure capsule was required to transmit the pressure to the outside of the calorimeter without loss or pollution of its fluid contents. It was made of a pair of stainless steel disks, each 2 inches in diameter and over one-half inch thick, clamping a 0.0025-inch silver diaphragm at the edge. The pair of disks were hollowed out to conform to the shape of the deflected diaphragm so that it would be supported without excessive strain when large pressure differences were applied, yet left free to balance small pressure differences. The total volume displacement of the diaphragm between supports was only 0.04 cm.³ Water extended from the outer side of the diaphragm to a water-air meniscus in a glass capillary indicator. A motion of the meniscus of 0.6 mm indicated a change of pressure of 0.001 atmosphere when the diaphragm was near the center of the cell. The pressure was transmitted by the air to an air-oil meniscus in another capillary and from that through the oil to the pressure gage.

The pressure gage was one of the rotating dead-weight precision piston gages constructed at the N.B.S. and described by Meyers and Jessup (*15*). The piston of this gage could be loaded with weights to balance the pressure to a precision of about 0.001 atmosphere. The oil not only supported the rotating piston but lubricated it as well.

The preparation for vapor-pressure determinations consisted in maintaining a constant temperature in the partly filled calorimeter for a sufficiently long time to be certain that the wall temperature of the calorimeter represented the temperature of

the free liquid-vapor surface. The pressure in the piston gage was then brought into balance with the vapor pressure in the calorimeter and simultaneous determinations were made of the load on the piston, the resistance of the platinum thermometers in the reference block, and the e.m.f. of the differential thermoelements leading from the reference block to the calorimeter.

At temperatures up to 350°C. the measurements were relatively simple and definite. Above 350°C. the steady state was reached much more slowly and temperature gradients were larger over the calorimeter shell. Near the critical temperature, where the specific volume of the saturated water changes most rapidly, it was necessary to start measurements with the calorimeter full of water and then continue measurements at successively reduced fillings so that the liquid would be at the proper level for some filling.

In 1934 Osborne and Meyers (*16*) published "A Formula and Tables for the Pressure of Saturated Water Vapor in the Range 0 to 374°C." For the upper range of temperature, this formula was based on the three recent researches mentioned above and in the range below 100°C. upon the classic data which were obtained at the Physikalisch-Technische Reichsanstalt (*17*) before 1909. The form of equation was one that, in the judgment of the authors, closely represented the data, and was suitable for numerical calculation of the pressure and its derivative. This formula was used to compute tables of both the vapor pressure and its slope at intervals of 1°C. and 1°F. over the range. These intervals are small enough so that linear interpolations suffice to determine either the pressure or its derivative at nonintegral temperatures.

When the measurements of the vapor pressure had been completed, a few extra accessory parts were installed in order to make the calorimetric measurements. Among these accessories (*18*) were two sensitive throttle valves, one for throttling the liquid, and the other for throttling the vapor. These valves were of the diaphragm type, which had no stuffing boxes. The motion necessary to adjust the throttling was produced by a screw, acting on a long lever supported on knife-edge bearings. Backlash was eliminated by a spring, acting on another similar lever which opposed the thrust of the screw. When the levers had been adjusted to give approximately the correct flow, it was thereafter controlled by varying the tension of the springs to the backlash levers. This control proved to be very delicate and positive. It was adequate for the control of temperature and was free from the annoyances which had been caused by the pivoted bearings of the throttle valves used with the first calorimeter.

The control of the temperature of vaporization was accomplished by controlling the vapor pressure at the free surface where evaporation was taking place. This method of control of the temperature of vaporization is nearest to the ideal because there is little question that the temperature of the free surface responds almost instantaneously to changes in the pressure of the vapor above the liquid. Part of the same pressure line that had been used for the vapor pressure measurements was used for this control, but in place of the piston gauge there was an air reservoir, which was kept immersed in an ice bath to maintain a constant reference pressure. The pressure in this reservoir was first adjusted to balance the pressure in the calorimeter when equilibrium existed, then after the power was switched on, the flow of fluid out of the calorimeter was continuously adjusted to maintain this same pressure balance and hence the same temperature at the evaporating surface.

The β experiments were performed by starting and stopping the flow of liquid in the same manner as was done in experiments with the first calorimeter. The γ experiments were performed by two methods, one by switching the flow of vapor from one receiver to another as with the first calorimeter, and the other by the start and stop method used for the β experiments. This latter method of performing the γ experiments was made more reliable by the temperature control of the free surface just described. The resulting values of γ when compared with those obtained by the first method and with those obtained with the first calorimeter did not show any sig-

H. F. Stimson, President, Philosophical Society of Washington, 1944

nificant systematic differences resulting either from the method or the apparatus.

As before, the α function was derived from repeated measurements with both high and low fillings. These covered each 10° interval from 100° to 370°C. with the addition of numerous measurements over 50° intervals from 100° to 350°C.

The β function was derived from measurements at temperatures from 200°C. up but at more closely spaced temperatures toward the critical temperature where the slope of the β function changes most rapidly. The measured values of β were compared with values calculated from the M.I.T. (*19*) pressure-volume-temperature measurements by means of the Clapeyron relation. At temperatures below 220°C. the derived β was undoubtedly more trustworthy than the measured β. Between 220° and 330°C. the precision of the measured β is comparable with that of the derived value but above 330°C. the measured values of β are more reliable and therefore were used in the formulation. Conversely, this means that the values of the specific volume of the liquid above 330°C. are more reliable when derived from the vaporization experiments than when derived from the pressure-volume-temperature measurements.

Measurements were also made on the γ function at temperatures from 100°C. up to and including 374°C. As the critical temperature (N.B.S. estimate 374.15°C.) is approached, the specific volume of both the liquid and the vapor approaches equality, and the liquid and vapor tend to mix owing to such causes as residual temperature gradients and thermal agitation. It is to be expected that at some temperature near the critical the mixing of phases will be so great that liquid will be withdrawn along with vapor in the γ experiments and vapor with the liquid in β experiments. Provisions, such as baffles at the upper and lower ends of the calorimeter, were made to avoid this as far as possible. In the experimental program, the rates of withdrawal were varied in order to detect mixing. It appears, however, from the consistency of the results, that there was no positive evidence of mixing until the fluids were within 1° of the critical temperature. At 373.5°C. both the β and the γ experiments indicated indeterminate results, whereas, at 373°C. and lower, there was little, if any, evidence of it.

In the specific volume determinations made at M.I.T., however, isometric lines must be extrapolated to the saturation line from the compressed liquid or the superheated vapor. As the critical temperature is approached, the curvature of these isometric lines increases toward the saturation line and the extrapolation becomes more uncertain. For these reasons, it appears that the thermal properties of saturated water and water vapor can be most reliably measured with a saturation calorimeter, as the critical temperature is approached. Very close to the critical temperature, even these measurements become indeterminate.

These measurements concluded the determination of the properties of saturated water and water vapor at high temperature but left the enthalpy of the saturated vapor below 100°C. almost untouched. In the meantime there had arisen a request for increased accuracy in the determination of the properties of saturated liquid below 100°C. where water is most frequently used for the exchange of energy in certain types of calorimetric experiments. It was therefore decided to make a third apparatus (*20*) to measure the enthalpy of saturated liquid to an accuracy of 1 part in 5,000 and also to use this apparatus to complete the measurements of the heat of vaporization of water over the entire range down to the freezing point.

Since 100°C. was set as the upper limit of temperature required, it was unnecessary for the calorimeter to withstand any pressure difference of more than one atmosphere and hence the calorimeter could be larger and of much lighter construction. This calorimeter was made of pure copper, 0.022 inch thick, spun into two hemispherical shells 5 inches in diameter and soldered together with a narrow cylindrical copper band at the equatorial zone. The surfaces inside and out were gold-plated and the outside surfaces polished to make the emissivity low. A circulating pump consisting of two screw propellers was provided to agitate and circulate the water, and guide vanes were provided to direct the flow. A

sheathed heater in a flat horizontal coil provided the power for the experiments. As before, the calorimeter was supported by tubes at the poles. The lower tube was small and contained the pump shaft while the upper one was large to conduct large volumes of vapor out of the calorimeter in those γ experiments where the specific volume was large.

The envelope was a double-walled vapor bath, entirely surrounding the calorimeter. This bath always contained a small quantity of liquid water so that saturated vapor bathed the entire inner wall. Heat applied to the outside wall at the level of the water in this bath caused vapor to be formed which had access to all parts of the bath without any appreciable drop in pressure. Any portion of the entire inside surface, which chanced to be at a temperature lower than that corresponding to the vapor pressure, immediately received the latent heat from condensation on that portion. Provision was also made to keep the inner wall bathed with a film of liquid which could evaporate to cause cooling wherever necessary. The inside of the inner wall of this envelope was gold-plated and polished to make the emissivity low where it faced the calorimeter. The space between the calorimeter and the envelope was evacuated when thermal insulation was needed, but it was filled with helium when thermal connection to the envelope was desired, such as when refrigeration was needed to cool the calorimeter and its contents before starting a day's run near 0°C. At such times a flow of ice water in a condenser at the top of the envelope vapor space caused condensed water to run down over the inner wall where it evaporated and thus cooled the wall.

The copper reference block for this calorimeter was inclosed in a cylindrical extension of the double-walled envelope enclosure so that its temperature would be the same as that of the envelope around the calorimeter. This copper reference block had axial sockets for the usual laboratory type of resistance thermometers and had 22 thermoelements attached.

Since higher accuracy was sought, special attention was directed both to the details of the design and to the technique of measurement. The greater difference in the masses of water in the high and low fillings was one factor toward this end. Other factors included the measurement of power and temperature. The potentiometer calibration was checked at least twice a day against saturated standard cells kept in a special temperature-controlled box. Many calorimetric measurements of the pump power showed some irregularities, as before, but since the total pump power was less than 0.005 watt, these irregularities were of little consequence. The heat leak corrections due to temperature differences between the calorimeter and the envelope were taken into account although they seldom made an effect of as much as 1 part in 50,000.

No β experiments were made with this calorimeter because β is small in this temperature range and it could be computed more accurately than it could be observed. The γ experiments were made with a throttle very similar to the one in the second calorimeter, but larger. The steam throttled through this valve was collected in glass reservoirs through tubes and stopcocks, which were nowhere less than 1 cm in diameter. When in use the bottom of these receivers was immersed in liquid air which maintained the vapor pressure at a negligibly low value. Vaporization experiments were made at temperatures as low as 0.13°C. where the specific volume of the vapor is over 200,000 cm³ per gram.

The results (*20*) obtained with this calorimeter were expressed in terms of enthalpy in the same manner that the earlier results had been, but in this temperature range there is also another important property, namely, the specific heat at constant pressure denoted by the symbol C_p. To derive this quantity the values from the α experiments were reduced to weighted means of $\Delta\alpha/\Delta T$ at the midtemperatures of all the intervals of the range. These were then reduced to $\dfrac{\Delta H_{\text{sat}}}{\Delta T}$ by means of the β function, then to $\dfrac{\Delta H_{1\text{ atm}}}{\Delta T}$, and finally to $\dfrac{dH_{1\text{ atm}}}{dT}$ which is the C_p. The weighted mean values

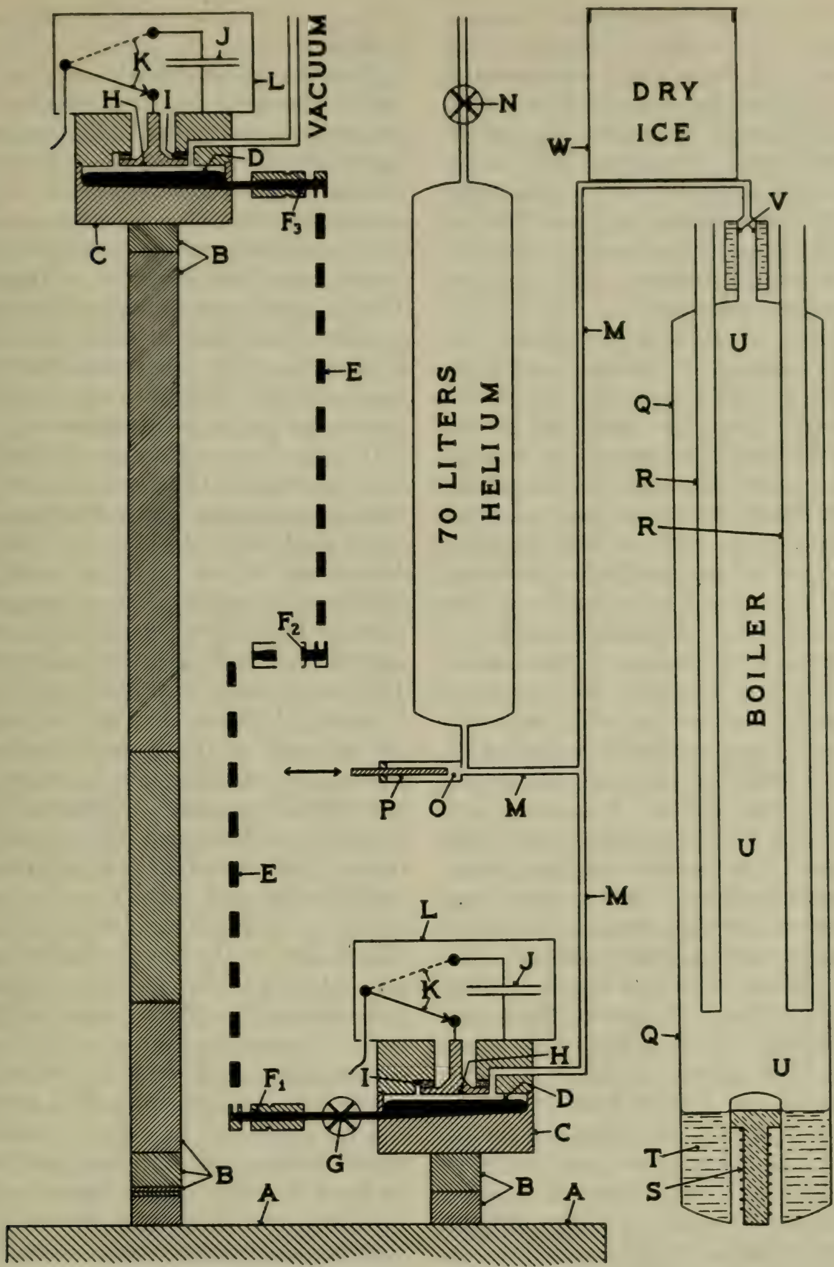

FIG. 1.—Schematic diagram of precision manometer, with boiler for vapor pressure measurements: A, Base plate; B, column of Hoke gage blocks 1 inch square; C, mercury cell; D, mercury meniscus, 73 mm in diameter; E, arm of jointed tube $\frac{1}{8}$ inch I.D. to connect mercury cells, dotted to indicate that it is back of plane of cells; F_1, F_2, F_3, tube joints, shoulder, elbow, and wrist; G, valve to shut off the mercury connection between cells; H, capacitance plate 35 mm in diameter, 0.2 mm above mercury; I, electric insulation, gas tight; J, fixed capacitance, equal to plate-mercury capacitance; K, pneumatic switch, connecting either to fixed capacitor or to plate-mercury capacitor; L, electrostatic shield; M, helium line; N, helium supply valve; O, 7-milliliter volume for pressure adjustment; P, piston for micrometer adjustment of pressure; Q, thermometer boiler; R, thermometer well; S, heater for boiling water; T, liquid water; U, water vapor; V, vapor condenser with cold water; W, dry-ice cell for keeping helium line dry.

of C_p, which may be considered as experimental values, were then formulated into an equation. All these mean experimental values of C_p fell within one part in ten thousand of the formulation except for two at temperatures below 5°C., which had a very low weight. This accord contributes confidence to the formulation but should not be taken as an estimate of accuracy, however, because systematic errors could well be larger than the accidental.

The results of this investigation corroborate the results of Rowland, of Laby and Hercus, and of Jaeger and von Steinwehr, but differ from the results of Barnes in the upper part of the range by an amount somewhat greater than can be reconciled. The results obtained in this range with the first calorimeter, reported in 1930, were not so accurate as the later results and were not considered as entitled to inclusion in the formulation of values of specific heats.

The latest determinations of the specific heat of water are of interest in comparing two artificially defined calories with the calories they were originally intended to represent. In 1929 the International Steam Table Conference defined a calorie, now known as the I T cal (International Table calorie) to be 1/860 international watt hour, which is equivalent to 4.1860 international joules. This calorie was originally selected to be the mean calorie, which is about equal to the 11.5° calorie although it now appears to be nearer to the 14° calorie. The other artificial calorie is the thermochemical calorie used in thermochemical research laboratories in the United States and defined equal to 4.1833 international joules. This calorie was taken over from the International Critical Tables where it was intended to be the 15° calorie but now appears to be nearer to the 17° calorie.

This about completes the list of researches on water under the leadership of N. S. Osborne. It leaves one gap, however, which he had hoped to see filled, namely, the measurement of the vapor pressure of water at temperatures below 100°C. The Reichsanstalt values (*17*) are still widely used but it is believed that more accurate values can be obtained with the present advances in the technique for measuring pressure and temperature.

Pressure measurements can now be made with a precision mercury manometer, constructed at the N.B.S. This manometer is one of the principal elements of a constant volume gas thermometer with which it is intended ultimately to determine the temperature of several fixed points on the absolute thermodynamic scale of temperature. The aim has been to make this manometer capable of yielding an accuracy of one part in a million, for the measurement of any pressure from nearly two atmospheres down to about a tenth of this pressure.

In order to avoid errors due to the capillary depression of the two mercury menisci, these menisci were nearly 3 inches in diameter in rigid steel cells (Fig. 1). The capillary depression at the center of each cell was calculated to be less than a thousandth of a micron. The cells were inter-connected by a jointed steel tube in order to accommodate different levels of the upper cell, from 0 up to about 55 inches. The cells were mounted on columns of Hoke gage blocks, 1 inch square, set on a flat iron base plate. These gage blocks permit adjustments of height in steps of 0.0001 inch, the routine calibration of the longer blocks is made to 2 parts in 1,000,000 and they may be wrung together to about a hundredth of a micron. The height of the mercury surface in each cell, relative to its supporting gage blocks, is determined by measurements of the electrostatic capacitance between the mercury surface and a steel plate 35 mm in diameter about 0.2 mm above it. This capacitance can be compared in a few seconds with a stable dummy capacitor in a shielded space on top of the cell. Small ripples on the mercury surface, which are caused by almost continuous earth tremors, and which would exclude its use as one mirror of an optical interferometer, do not affect the capacitance measurements. The capacitance is measured with a beat-frequency oscillator which is sensitive to a change in the height of the mercury surface of about a hundredth of a micron.

It was intended to give this manometer its first workout in making measurements of

the vapor pressure of water at pressures within the capacity of the manometer. A few preliminary measurements have been made at 80°, 60°, 50°, and 25°C. with active boiling of water in a specially designed thermometer boiler. At the top of this boiler there was a condenser where the stream of water vapor condensed and transmitted its pressure to helium extending to the lower cell of the mercury manometer. It soon became evident, however, that the vapor pressure of water could be measured with a much greater accuracy with this manometer than the corresponding accuracy to which temperature could be measured with thermometers calibrated by routine methods. For this reason further measurements were deferred until a few more refinements could be put on the calibration of the platinum resistance thermometers.

This apparatus is suitable for providing and maintaining a pressure very precisely at one atmosphere for calibration of thermometers at 100°C. Pressures can be maintained constant within one part in a million for periods of an hour or more at will. At 100°C. this corresponds to a temperature constancy of much better than 0.0001°C. The determination of the steam point in a closed system connected to this manometer is as much superior to determinations in apparatus open to the atmosphere, as determinations of specific and latent heat of water in closed calorimeters were superior to measurements where water samples were caught in open vessels for weighing.

It had been recognized for a long time that individual steam-point determinations in open boilers are subject to uncertainties of a few thousandths of a degree, but it had not been fully appreciated that ice-point determinations, without special technique, are also subject to uncertainties of one or more thousandths of a degree. The ice point, or 0°C., is defined *(21)* as the "Temperature of equilibrium between ice and air-saturated water at normal atmospheric pressure." When this definition was set up, the ice bath, made of finely divided pure ice and distilled water exposed to the atmosphere, was assumed to be sufficiently accurate to fix this temperature to 0.001°C. When an accuracy of 0.0001°C. was desired there was some uncertainty in the precise realization of the conditions of the definition as will be seen. It was recognized that the temperature of pure water at the triple point was the simpler to define precisely, but it was considered that the apparatus for using it was too complicated for routine testing.

Since water expands on freezing, the temperature of equilibrium of ice and water is lowered by pressure. Using what are believed to be the best data now available, this lowering has been computed to be 0.00747°C. when the water is subjected to one atmosphere pressure. Foreign substances in solution also lower the freezing temperature. There are uncertainties about the exact values for the solubilities of the constituents of air in water but computations show that normal outdoor air containing 0.03 percent of CO_2 lowers the freezing temperature by about 0.00244°C. when the ice bath is at one atmosphere pressure. The pressure and the dissolved air together lower the freezing temperature by about 0.00991°C., which means that the triple point is nearly 0.0100° above 0°C. This difference of temperature has been determined experimentally by four reliable experimenters, viz., H. Moser *(22)* at the Reichsanstalt, W. P. White *(23)* at the Geophysical Laboratory, J. L. Thomas *(24)* at the National Bureau of Standards, and J. A. Beattie *(25)* at the Massachusetts Institute of Technology. All four reported the triple-point temperature to be 0.0098°C. above the ice point. This temperature difference is less than the theoretical, but it could be accounted for either by the presence of foreign matter in solution in their triple-point cells or because the water in their ice baths was not fully saturated with air at the ice-water interfaces nearest their temperature measuring instruments. It is well known that the saturation concentration of air in ice is much less than in water. For this reason water from newly melted ice will not be fully saturated with air until the necessary amount of air has had time to diffuse into it all the way from the surface of the ice bath. Since temperature is determined by the conditions at the ice-water

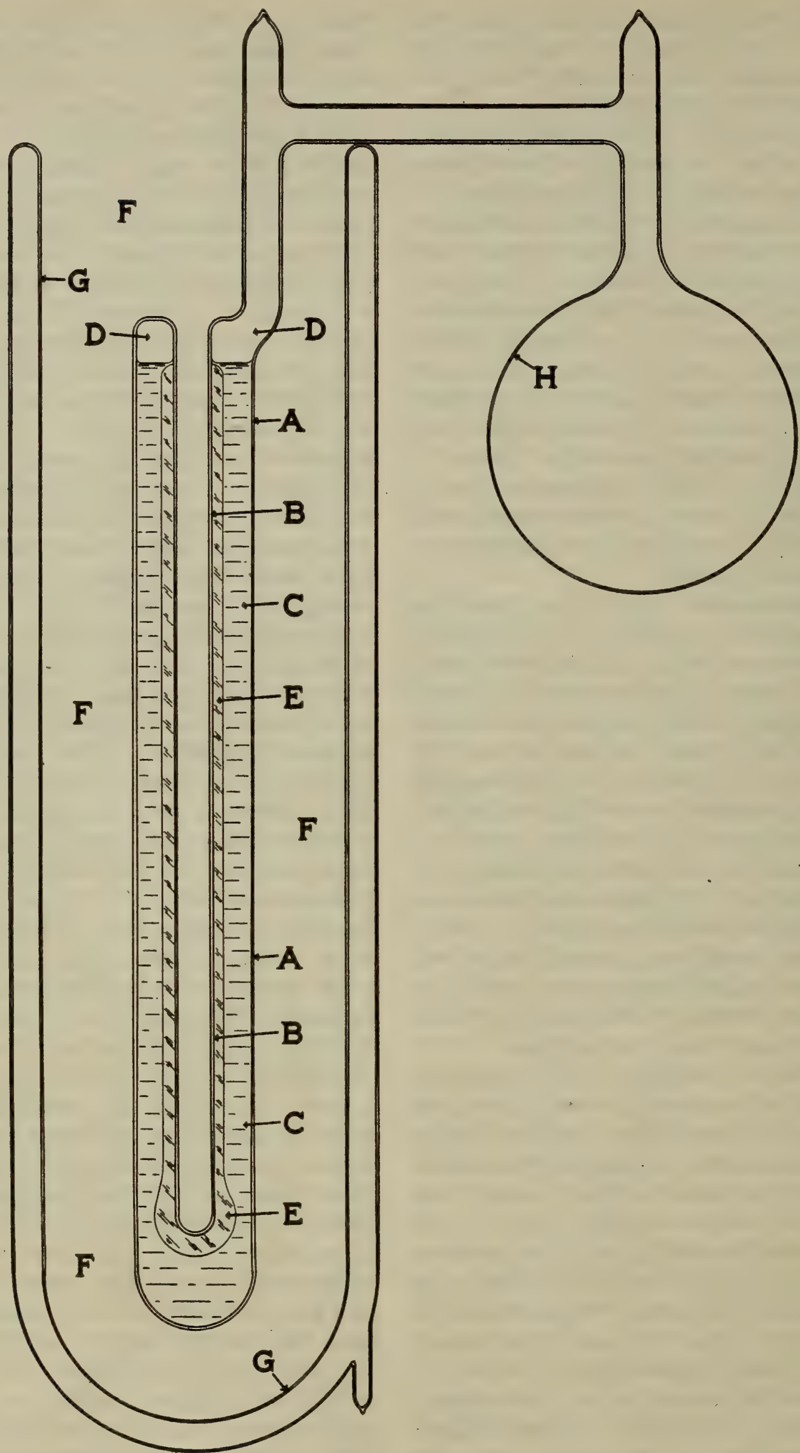

FIG. 2.—Triple-point apparatus: A, triple-point cell; B, thermometer well; C, liquid water; D, water vapor; E, ice mantle; F, ice bath; G, vacuum vessel; H, flask for redistillation.

interfaces, it follows that complete saturation of air in water under normal atmospheric pressure must extend to the interfaces nearest the thermometer to realize the defined temperature of 0°C. in water that is pure otherwise. It becomes a bit delicate, therefore, to get the water completely polluted with air at the ice surface but with nothing else. White and Beattie provided means for washing the ice in the ice baths with successive changes of distilled water saturated with air at 0°C. Melting ice, as suggested in the publication "The International Temperature Scale" (*21*), almost certainly will prevent complete saturation of the water with air.

After these considerations a triple-point apparatus for precise determinations of temperature did not seem as formidable to make and use as a precision ice-point apparatus. Several triple-point cells (Fig. 2) were prepared and a suitable technique was developed to use them effectively. When in use these cells were completely immersed in an ice bath. The cells were of Pyrex glass about 2 inches in diameter and about 16 inches long with one-half-inch reentrant coaxial wells for the thermometers. Each cell also had a tube extending out through the top of the ice bath to a spherical 1-liter flask at the side. Each cell was filled nearly to the top with ordinary distilled water, which had been air-freed, repurified, and then distilled into the cell before sealing off. When the water was sealed in the apparatus, any non-volatile contamination such as dissolved glass could be eliminated at will by pouring the liquid into the flask and allowing it to redistill quietly into the cell by keeping the cell in an ice bath for about a day.

The cells were prepared for use by freezing a mantle of ice on the thermometer well with solid CO_2, commercially known as dry ice. Dry ice was dropped into a little ethanol in a glass tube which was like a long test tube, fitting freely into the well. The space between the tube and the well was filled with ethanol and the tube agitated up and down in order to cause the ice mantle to form uniformly on the outside of the well. Agitation was continued until the mantle of ice was from 3 to 6 mm thick, and then the tube was let down for a while to thicken the mantle at the bottom. During the process of freezing, impurities tend to be excluded from the ice and therefore concentrate in the water at the surface of the ice where they exaggerate the lowering of the freezing temperature until after these impurities have had time to diffuse away from the surface throughout the water in the cell. Most of this lowering can be avoided by the simple expedient, suggested by W. P. White (*23*), of heating the well just enough to melt ice to give a thin film of water next to the well, which is where the ice first was frozen and where the purest ice exists. This surface then surrounds the thermometer well and provides a simple means of almost completely enclosing the thermometer in a surface which is isothermal except for the small temperature gradient due to the increase of pressure with increasing depth of immersion. These cells take only a few minutes to prepare for use and can be kept for many hours in an ice bath. They are probably reliable to about ten times the precision of the usual ice bath and when available they do not require a much longer time to prepare for measurements.

With the triple-point cells available, there arose the question of the precise temperature of the triple point, relative to the defined ice point. This meant that the defined ice-point temperature would have to be realized to compare it with the triple-point temperature. To do this, an ice-point cell (Fig. 3) was made which in principle resembled the triple-point cell but also had provisions for saturating the water surrounding the ice mantle with air. Extra care was taken during the distillation and purification of the water introduced into this cell so that it could be kept pure. Several days were required to prepare the water sample which was then sealed into the cell so that it could be used first like a triple-point cell.

To prepare for the determination of the triple-point temperature, ice was frozen on the thermometer well of the ice-point cell and also on the walls of three triple-point cells. Triple-point temperatures were ob-

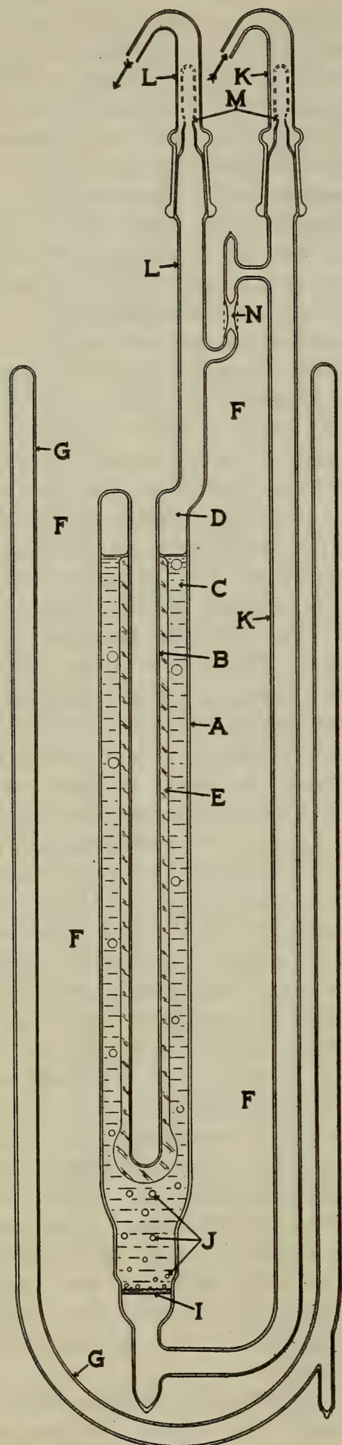

Fig. 3.—Ice-point apparatus: A, ice-point cell; B, thermometer well; C, liquid water; D, water vapor and air; E, ice mantle; F, ice bath; G, vacuum vessel; I, fritted disk; J, air bubbles; K, air inlet tube; L, air outlet tube; M, tip broken to admit air; N, bypass, sealed after air admission.

served first in triple-point cells and then in the ice-point cell using the exterior surface of its ice mantle. When this had been done the ends of the two tubes that led to and from the cell were cut off. This admitted the pressure of the atmosphere to the liquid surface in the cell and lowered the temperature. The temperature was then observed as soon as possible, and temperature observations continued for some time, so that the temperature could be extrapolated back to the time of admitting the pressure. Since air could not diffuse immediately from the top surface of the water down to the ice surface surrounding the thermometer, the extrapolated temperature difference was assumed to be caused by the pressure of the atmosphere.

Air, free of CO_2, was then forced into the cell through a fritted disk beneath the thermometer well, thus causing small bubbles to rise past the ice mantle and to saturate the surrounding water with air. This process was continued for a long time until temperature equilibrium was established. This temperature was assumed to be the temperature of equilibrium between ice and air-saturated water free from CO_2 at standard atmospheric pressure. The thermometer was then put into the triple-point cells again to check the thermometer and bridge for any drift during the day.

With the observed temperature, corrected to the basis of standard atmospheric pressure and 0.03 percent of CO_2 in the air, the temperature determined for the triple point of water in this one experiment was 0.00997°C. (*26*), with no claim made for the reliability of the last decimal figure. Only one experiment was performed, however, because immediately afterward, in 1942, this research had to be set aside for work of higher priority.

The result of this experiment indicates that the temperature of the triple point of water is near enough to 0.0100°C. for most purposes. It is consequently suggested that a future precise definition of the centigrade scale of temperature might define 0°C. as being 0.0100° below the triple point of water, instead of refining the present definition to include a specification for the precise composition of air. Such a change would make no significant difference in the present

temperature scale, but would make the definition simpler, more precise, and easier to realize when the highest precision is demanded. Moser (*22*), in 1928, recommended "the triple point of water as a fixed point of the temperature scale" and the experiments, described here, strengthen this recommendation.

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ARCHEOLOGY.—*The significance of the fiber-tempered pottery of the St. Johns area in Florida.*[1] JAMES B. GRIFFIN, Ceramic Repository for the Eastern United States, Ann Arbor, Mich.

Any discussion of fiber-tempered ware in the Southeast and more particularly in Florida must begin with the observations of Jeffries Wyman, who investigated the area in 1860, and again in 1867, and whose monograph on fresh-water shell mounds of the St. Johns, published in 1875, is still a significant contribution. He recognized that the pottery from the St. Johns shell heaps had little similarity to other Florida pottery and that cord-marked pottery did not often occur there while it did occur in the marine shell heaps near St. Augustine and along the Atlantic coast to the south. He observed that the check stamp was fairly common at the coast and river sites. Part of the distinctiveness of the St. Johns pottery was the ware tempered with fiber. Wyman says (1875, pp. 55–56)[2]:

> In several localities, as will be seen by the table, the natives added to the clay vegetable fibre derived from the palmetto tree. This appears to have been charred in the burning, thus making the vessel quite porous, each fibre leaving in its place, or around it as it shrunk from the heat, a small canal. In finishing the vessel, however, after it had been formed of fibre and clay, the surface within and without were covered with a thin layer or "skimming" of clay alone, thus counteracting in a measure the porousness resulting from the burning of the fibre. The only places at which this use of vegetable fibre was noticed were Old Town, Old Enterprise, Watson's Landing, as given in the table, and at Silver Spring on Lake George, and Palatka. This may, perhaps, be explained by the fact that the different communities had their own makers, each adopting a more or less peculiar style.

Wyman interpreted the absence of pottery from some of the mounds as evidence that they were earlier than the shell heaps that had pottery. This viewpoint was upheld by Moore as a result of his excavations along the St. Johns, and he added the observation that in some of the mounds pottery was found on the surface and part of the way toward a nonpottery basal layer. Holmes (1894) described the pottery from Moore's (1892–1894) early excavations and called one of his ceramic divisions "Midden Ware." He subdivided the midden ware into two groups. "One variety is characterized by a rather fine-grained paste preserving the warm gray colors of the baked clay. The surfaces are finished with a rubbing tool and are plain or have been rather carelessly embellished with patterns of incised straight and curved lines." The other subunit of the midden ware was fiber-tempered. At the time of my earlier studies on southeastern fiber-tempered ware, I had not seen examples from the St. Johns sites, and this has now been happily remedied.

While preparing a paper which interprets the cultural history of the eastern United States area, it appeared likely that the style and design of this pottery formed one of the component elements of the Tchefuncte ceramic complex of Louisiana and was hence at least as old as and probably older than the pottery from that aspect (Griffin, n.d.). At that time (1941) I compared the design to Alexander Incised of the early sand-tempered Alexander Series in the Southeast and after examining Wyman's collections in the Peabody Museum in Cambridge and Moore's collections in the Heye Museum in December 1941, I referred to the rectilinear design on fiber-tempered pottery as resembling Alexander Incised.

In March 1942 A. T. Anderson, of Melbourne, Fla., came to the Ceramic Repository for the Eastern United States at Ann Arbor and brought with him photographs of excavations and specimens from a site on his land, which is located almost due west of Melbourne on the St. Johns. From Anderson's account of the excavation it was evident that he had uncovered a significant

[1] This paper was read before the annual meeting of the Society for American Archaeology in Washington, D. C., in May 1944. The site at South Indian Fields was called to the attention of Dr. Irving Rouse, of the Peabody Museum of Yale University, who directed a field party which partially excavated the site in July and August 1944. A series of papers on these excavations and related Florida problems will be published by Yale University in the near future. Received March 5, 1945.

[2] See Literature Cited at end of paper.

site and that the lowest pottery bearing horizon was related to the incised fiber-tempered ware recovered by Wyman and Moore. The following description of Orange Incised and Orange Plain is based on Anderson's collection, on the earlier published reports and my examination of material in Cambridge, New York, and Washington.[3]

TYPE NAME: Orange Incised.

PASTE:

Method of manufacture: No evidence.

Temper: Fiber-tempered. Various proportions and sizes of a vegetal fiber almost entirely disintegrated in firing, presenting a vesicular appearance. There is no other nonplastic material visible in the clay.

Texture: Honey-combed.

Hardness: At least three-fourths of the sherds can be scratched by gypsum, while the others are 2–2.5.

Color: The exterior surfaces vary from a light cream to a dark gray. The surface color penetrates but a short distance (1 to 2 mm) and the core is very dark gray to black.

SURFACE FINISH: Both exterior and interior surfaces are fairly well smoothed. On some specimens this is sufficient to have formed a film over the fiber strands. On the majority of sherds the fiber tracks are visible on the outer or inner surface.

DECORATION:

Technique: Incising and punctating. The incising varies from lines made with a fine sharp point which are narrow (less than 2 mm) and medium deep, to medium wide (2–4 mm) and medium deep to deep incisions made with a rounded point. There is considerable variation in the skill of execution. The punctates are small shallow circular indentations or ovoid-shaped gashes.

Design: The designs are all rectilinear and are placed on the lip and outer rim or side wall of the vessel. The following patterns can be recognized.

1. Parallel vertical lines extending from the lip to the base of the wall.
2. Parallel horizontal lines extending from the lip to the vessel base.
3. Parallel left or right oblique lines extending from the lip to the basal angle.
4. Left and right oblique cross-hatched lines extending from the lip to the basal angle.
5. Large triangular areas with oblique hatching.
6. Groups of four or more oblique lines separated by a parallel plain band.
7. Groups of lines forming chevrons or inverted chevrons separated by a plain area.
8. A series of nested squares.
9. Nested squares or diamonds with vertical oblique or horizontal intersecting lines running through the corners of the squares or diamonds.
10. Hatched oblique bands outlined by incised lines.
11. Hatched areas set off from plain bands by incised lines.
12. Horizontally hatched triangles with adjoining inverted triangle plain.
13. Circular punctates or ovoid gashes paralleling or at right angles to incised lines.
14. Groups of oblique lines or chevrons on lip surface sometimes bordered by punctates.
15. The use of horizontal lines along the upper rim to delimit the decorated zone. This is used particularly with patterns 8 to 11 inclusive.

FORM:

Rim: Vertical, to slightly insloping in the upper segment of some specimens. There is no differentiation between a rim fragment and a side wall specimen.

Lip: Narrowed and rounded and without decoration, or very wide and decorated with incised lines and punctates. There is a tendency for the first 6 decorative patterns to occur on rims with narrowed lips and for patterns 8 to 11 to have wide, decorated lips. The flat lip may be horizontal or slope toward the interior.

Body: Rather shallow rimmed bowls or pans. Height from 7 to at least 15 cm. with the diameter varying from 20 cm. to vessels which were much larger.

Base: Flat. Some sherds presumed to be basal fragments have incised decorations of pattern 13 on their interior surfaces.

[3] The Department of Anthropology of the United States National Museum has kindly allowed me to reproduce a series of sherds from the Tick Island shell mound.

Thickness: Considerable variation from vessel to vessel. Narrow lips are 6 to 8 mm; the wide lip from 1.5 to 2.7 cm. Side walls from 8 mm to 1.8 cm and basal section 8 mm to 15 cm. The basal section often the thinnest part of the vessel.

Appendages: None. Examples of crack lacing holes.

USUAL RANGE OF TYPE: In the St. Johns drainage from South Indian Field north at the following sites of Wyman and Moore: Mulberry, Orange Mound, Huntingtons, Watson's Landing, Black Hammock, Enterprise, Mound in Woods above Blue Springs, Old Town, Mound below Lake Dexter, Tick Island, Silver Spring, Murphys Island, Palatka. To the west specimens were obtained in Ocala National Forest by Marshall Newman.

CHRONOLOGICAL POSITION OF TYPE IN RANGE: The earliest pottery found along the St. Johns. Is not found at all in some deep shell middens, on top layers of others and on bottom of still other shell middens which have later pottery types toward the top.

The plain sherds which are quite similar to the incised specimens can be called Orange Plain and differ in a few particulars from the incised specimens. The surfaces are usually not so well smoothed and the pieces seem somewhat less well made. Both the narrowed lip and the wide flat lip are found and some of the latter have incised decorations on them. There is thus no reason to believe that the plain specimens are significantly older or that a similar succession of plain to decorated is found either at South Indian Field or farther north in the St. Johns drainage as has been reported from the Bilbo site.

According to Anderson there also occurred in the lowest pottery zones an entirely different ware, which is an early form of the dominant temperless pottery along the St. Johns, and to this might be attached the appropriate name of St. Johns ware. A number of types can be recognized. One of these is incised (Fig. 1, S and T) and gives every indication of having developed or evolved from the earlier Orange Incised. On it there is a strong use of the horizontal line just below the lip on the outer rim forming an upper border for the incised pattern. The designs include some obvious carry-overs, but they are not so varied as on the fiber-tempered ware. Another type is a large check stamp, which is on thick coarse appearing sherds. Plain sherds are, of course, found and can be considered St. Johns Plain. A number of interesting traits are present on some of these dominantly plain sherds. One specimen has heavy scoring marks on the interior surface. Five specimens have fabric or mat impressions on the outer surface of flat circular bases (Fig. 1, U). The St. Johns ware forms a minority group in the earliest or third level at the South Indian Field site.

In Anderson's second level St. Johns Plain becomes the dominant ware with a continuation of the incised type and a few sherds of the check stamp. A newcomer is a plain sandy or gritty ware, which is probably related to the Glades Gritty Ware of Stirling and Goggin (1940). One specimen may be a tubular pipe. At this level a red-filmed type appears on a bowl shape.

Between the second level and third level Anderson recovered most of a short and rather wide-necked water bottle made of St. Johns paste. St. Johns Plain continues into the third level and there was also found a large amount of small check stamp which should be named St. Johns Check Stamp. From the surface have come a few specimens of an olive-green glazed ware, which may well be the fragments of Spanish olive jars.

The sequence of pottery wares and types as reported by Anderson conforms very well with that from the sites excavated by Wyman and Moore and with other excavations in the Southeast. South Indian Fields should yield very important confirmation of the above suggested ceramic stratigraphy and in addition has a number of other interesting prospects. From the level in which the fiber-tempered ware was found, Anderson obtained the jaws of the West Indian seal (*Monachus tropicalis*), and he claims that horse and mammoth bones also occur there. An extinct beaver and ground sloth remains were obtained from levels below the earliest pottery horizon.

Of much more limited distribution in the St. Johns drainage is a type found in the central part of the St. Johns, which is characterized by a curvilinear scroll design

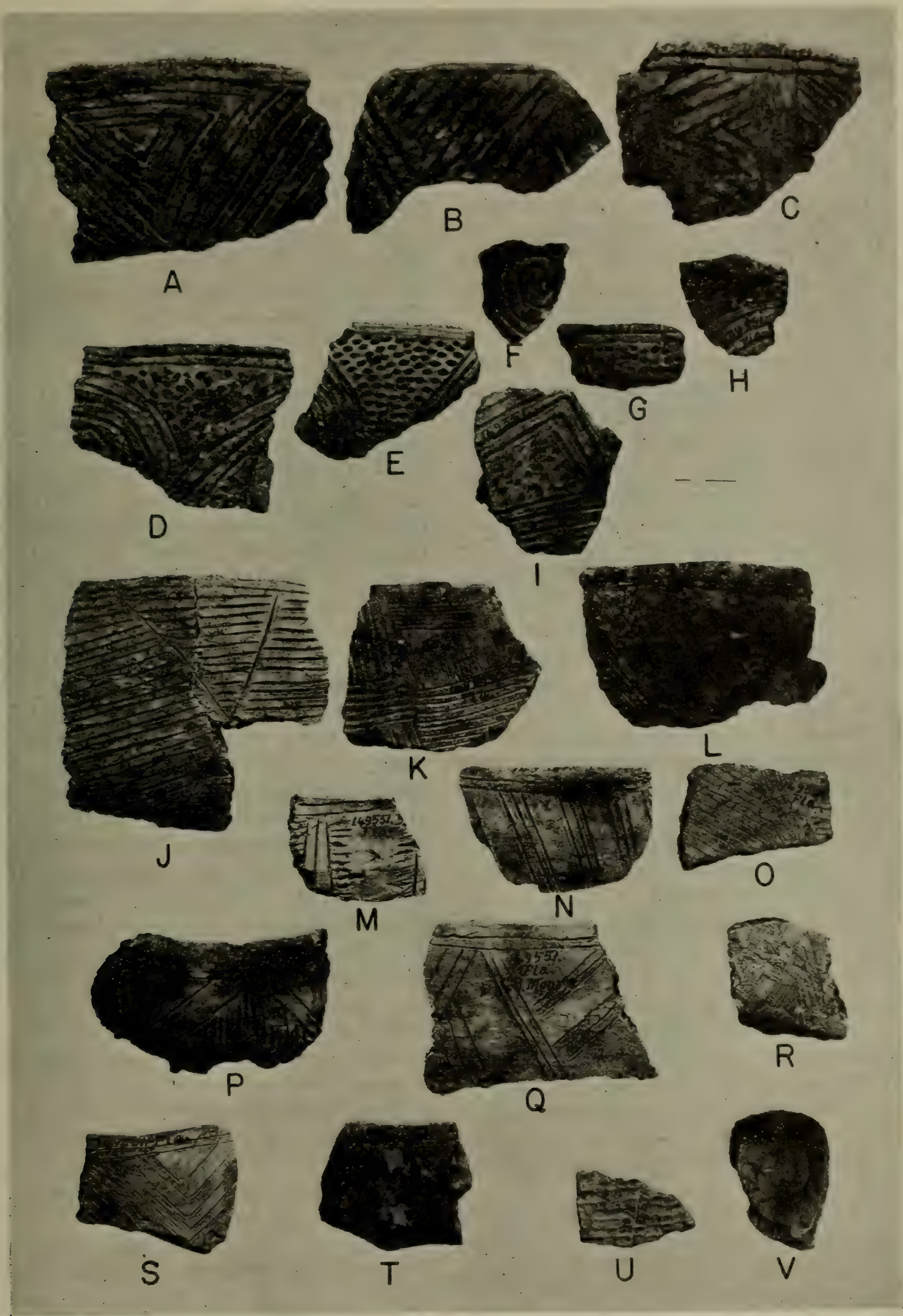

Fig. 1.—Sherds from the Tick Island site in the U. S. National Museum collection: A–C, Orange Incised with U-shaped lines; D–I, Tick Island Incised; J–R, Orange Incised; S–T, St. Johns Incised; U, mat impressed sherd on St. Johns paste; V, fragment of small bowl or ladle.

with closely spaced punctates filling in areas between the scrolls (Fig. 1, D to H). This punctate treatment very rarely is used with a rectilinear design (Fig. 1, I). This type can be called Tick Island Incised. The incised lines are usually medium-wide (2–4 mm) and U-shaped in contrast to the narrow (less than 2 mm) and V-shaped lines, which are more common on Orange Incised (Fig. 1, J to R). At the Tick Island site the U-shaped lines are more in evidence on the rectilinear designs of the Orange Incised style (Fig. 1, A to C), than is true toward the headwaters of the St. Johns. There is a rather strong suggestion in this Tick Island Incised type of a relationship with part of the Weeden Island pottery complex. It is difficult to be certain of the exact nature of this relationship. It is possible that the St. Johns potters copied one of the Weeden Island styles, in which case the two groups would be roughly contemporaneous. Another possibility is that this decorative technique and design appeared first in the Southeast in the St Johns and became one of the concepts incorporated in the Weeden Island complex. It is known that Weeden Island types do appear in the St. Johns, and they are associated, not with the Orange Series, but with the St. Johns Series (Moore, 1896; pl. 75 is an example). On the basis of the distributional evidence it is suggested that the Tick Island type is later than Orange Incised.

The fiber-tempered ware on the St. Johns is the third major center of this earliest ceramic tradition in the Southeast. All the fiber-tempered groups in the Southeast have the use of fibrous tempering material in common as well as the bowl-shaped vessel which is the only known shape. The appearance of other shapes and vessel appendages marks a significantly different and probably later step in the ceramic development in the southeast.

When the Orange fiber-tempered complex is considered in relation to the other fiber-tempered ceramic groups in the Southeast it is at once apparent that it is a remarkably homogeneous product and is limited to the area along the Florida east coast from the mouth of the St. Johns to its headwaters. It does not occur much farther north into the area occupied by the Stallings Plain or Punctate types (Griffin, 1943), nor has it been reported from the area to the south. Willey failed to find evidence of the Orange Series along the Florida northwest coast (although some fiber-tempered sherds were reported), and Moore would hardly have failed to mention such specimens if he had recovered them in his excavation in the same area. The Wheeler Series of fiber-tempered types in northern Alabama and the contiguous area does not show decorative influences or connections with the St. Johns types.

There is one other early pottery complex in the south that does show in some of its features a definite connection to the Orange types. In the Tchefuncte pottery complex one finds Tchefuncte Incised, Lake Borgne Incised, and Alexander Incised (Ford and Quimby, 1935), all of which show some connection to the incised fiber-tempered pottery of the St. Johns. The first two Tchefuncte types are granular clay-tempered pottery, while sand was used to temper the Alexander type. Not all the designs or even the technique of the Tchefuncte and Lake Borgne types resemble Tick Island, but there are a number of sherds in both groups which are very close. The strong use of linear punctate decoration in Tchefuncte resembles such employment in the Stallings Punctate pottery, but some of the designs on the Tchefuncte sherds resemble the Orange designs. It is reasonable to suggest that the Tchefuncte pottery complex in these particulars was influenced from the two major fiber-tempered centers in the southeast rather than the reverse. It is recognized that this is at present difficult to demonstrate.

Tchefuncte ceramics are indeed a very interesting agglomeration of ceramic concepts from a wide area. Mandeville Stamped has its analogue in the early dentate stamping of the rim in the Illinois Valley and throughout the Northeast. Tchefuncte Stamped is an inept expression of what Willoughby was wont to call the "hall-mark of the Algonquian potter." The Alexander types are found to the east in Mississippi and Alabama and bear as one of their distinguishing features the Woodland punched

out boss along the upper rim. On the basis of the present evidence Tchefuncte could hardly be regarded as the origin of these various pottery practices.

In my paper that will accompany the Yale University volume on Florida a more exhaustive comparative statement will be compiled for the ceramic and cultural sequence in the East Florida area. At present the St. Johns fiber-tempered pottery can be recognized as one of the oldest types in the southeast; it contributed decorative techniques and designs to later ceramic levels in the area.

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ZOOLOGY.—*Four new species of North American crabs of the genus* Petrolisthes.[1]

STEVE A. GLASSELL, San Diego Society of Natural History. (Communicated by WALDO L. SCHMITT.)

This paper describes three new species of *Petrolisthes* Stimpson from the Pacific and one from the Atlantic Ocean. Two of the species are new to the California coast but are neither obscure, rare, nor hard to obtain within their geographical limits. The new species from Panama, however, differs in this respect, its habitat being considerably restricted and local.

Petrolisthes manimaculis, n. sp.

Fig. 1

Not *Petrolisthes gracilis* Stimpson, Schmitt, Univ. California Publ. Zool. **23**: 181, pl. 32, fig. 4. 1921.

Types.—Male, holotype, and female, allotype, U.S.N.M. no. 79393, collected by the author from Morro Bay, Calif., at low tide, February 2, 1939.

Diagnosis.—Carapace nude, or lightly pubescent, lightly punctate, lateral margins roughened, front triangular, postocular tooth short, obtuse, no epibranchial spine, regions defined. Antennal flagellum smooth, blue. Carpus with sides subparallel, upper surface nearly smooth, or slightly roughened. Hands subsimilar, smooth, tuft of heavy pubescence in gape extending nearly to end on dactyl, less than halfway on pollex. Ambulatory legs with pubescence on upper margin of meri; merus of third leg twice as long as wide. In life, palp of maxillipeds blue, inner base of dactyl of cheliped orange, a median longitudinal row of blue dots on upper surface of palm.

Description.—Carapace in male slightly wider than long, female wider than male, depressed, regions defined, surface lightly punctate, punctae with microscopic pubescence, lateral regions lightly striate, no epibranchial spine, shoulders high, protogastric ridges divided by a median sulcus which deepens anteriorly, front triangular, slightly depressed, margins vertically sinuous, more than twice as wide as high, separated from upper orbital margin by a sulcus, upper margin roughened, tip blunt. Upper orbital margin elevated, no preocular tooth, postocular tooth obtuse, not

[1] Received March 14, 1945.

extending forward. First movable antennal peduncle armed with a cylindrical, tapered ridge, directed downward and outward, extending past distal extremity and slightly past proximal end of the cylindrical, smooth, second peduncle; flagellum smooth, almost nude, and more than twice the carapace width, color in life blue.

Chelipeds subsimilar, about three times the width of carapace in adult males, about two and a half times in females; merus with light transverse striae and a blunt, distal, inner lobe, not extending past inner margin of carpus; carpus nearly three times longer than wide in adult males, about two and a half times longer than wide in small specimens and females, margins subparallel, upper surface lightly roughened, a submedian, longitudinal elevation, outer margin rugose, with a sharp-pointed distal spine, some pubescence on the posterodistal half. Hands microscopically granular in adult males, more distinct in juveniles and females, inner margin an indistinct line of fine beading, outer margin blunt, sinuous, upper surface with a median, raised elevation, on which in life is a row of turquoise-blue dots. Dactyli unarmed, nearly as long as upper margin of palm, curved, sinuous, tips crossing pollex; a heavy felt of pubescence in gape which extends two-thirds the length of the underside of dactyl, and one-third the length of pollex; pollex unarmed.

Ambulatory legs with meri pubescent on upper crest, no posterodistal spine; merus of third leg twice as long as wide, other joints sparingly setose.

Sexual variation.—Female carapace wider, more areolate, rougher; carpus of cheliped more granulous, shorter; second antennal peduncle rough, granulated; ambulatory legs more pubescent; females smaller than males.

Color in life.—Ground color a rich brown, almost a red-chocolate, with large and small blue dots, giving the effect of blue lines, although they are actually a series of blue dots running together, this same effect being on the carpus and fingers of the hand. Median longitudinal ridge of the palm with a row of turquoise-blue spots. Legs a tan spotted with bluish white. Palp of maxillipeds margined with blue, inner proximal base of dactyl orange (Kirk).

Measurements.—Male holotype, carapace length 15.3 mm, width 16 mm; orbital width 8.5 mm; rostral width 3.5 mm, height 1.5 mm; antennal flagellum length 35 mm; major cheliped, length of carpus 16.5 mm, width 5.9 mm, length of hand 29 mm, width 11.5 mm; minor cheliped, carpus length 16 mm, width 5.5 mm, length of hand 29 mm, width 10 mm; merus of third ambulatory leg, length 8.5 mm, width 4.2 mm. Fingers nearly the length of palm.

Range.—San Francisco to San Diego, Calif.

Material examined.—The type series consists of several hundred specimens of both sexes, taken by the author at Morro Rock, Morro Bay, Calif., at low tide, on February 2, 1939. A series of about 50 specimens of both sexes, from Moss Beach, San Mateo County, Calif., taken in the latter part of May and the early part of June 1939 by R. Fields and E. Benton, under the direction of Dr. S. F. Light, of the University of California. Also a series of 30 specimens, both sexes, taken by the author at Spindrift Beach, La Jolla, Calif., at low tide, December 8, 1938. With the exception of distributed material all these specimens are in the author's collection.

Habitat.—This species occupies the lower levels of the intertidal zone. Its vertical range may be assumed not to exceed the mean low-water level. It, like most members of the genus, demands the shelter of rocks and weeds, uninfluenced by drifting sands. North of Point Conception, Calif., this species occupies an ecological horizon between *P. cinctipes* (Randall), which is above it, and *P. eriomerus* Stimpson, which is below. As neither *P. cinctipes* nor *P. eriomerus* is found south of Point Conception (except for the northernmost of the Channel Islands, San Miguel, Santa Rosa, and Santa Cruz), the southern association is changed, and *P. eriomerus* is replaced by *P. rathbunae* Schmitt, 1921, and *P. cabrilloa* Glassell (described as new in this paper) supplants *P. cinctipes*, although not in the same abundance.

Remarks.—This proposed species is allied to *P. eriomerus* Stimpson, 1871, but differs from that species in the following respects: (1) carapace without tubercles, (2) carpus two and a half to three times as long as wide, (3) carpus with upper surface smooth or slightly roughened, (4) inner base of dactyl of chelipeds orange (in *P. eriomerus* blue).

Stimpson's description of *P. gracilis*, by its brevity, has caused considerable confusion;

however, in the light of all the collections I have examined, it now appears to be a more or less localized species, restricted to the Gulf of California.

Petrolisthes cabrilloa, n. sp.

Fig. 4

Types.—Male, holotype, and female, allotype, U.S.N.M. no. 79391, collected by W. A. Kirk from Anaheim Landing, Calif., at low tide on October 11, 1939.

Diagnosis.—Carapace punctate, with light pubescence in punctae, striate on lateral margins; front triangular, obtuse, one-third as high as wide; postocular tooth short, obtuse, right-angled; no epibranchial spine; regions lightly indicated. Antennal flagellum ciliated, color ochre with purple edgings. Carpus about twice as long as wide, a proximal, inner marginal lobe, otherwise margins subparallel, upper surface pubescent, granulated. Hands subsimilar, granulated, a heavy tuft of pubescence in gape extending only halfway or less on both fingers. Ambulatory legs with pubescence and setae on meri. In life, palp of maxillipeds a brilliant orange, as is inner base of dactyli.

Description.—Carapace transversely flattened, convex fore and aft, small punctae in median areas and anteriorly, laterally striate, punctae microscopically pubescent, more prominent on front; protogastric ridges low, no epibranchial spine, shoulders moderately high. Posterolateral margins parallel. Front triangular, obtuse, three times as wide as high, slightly depressed, margins granulated, median sulcus, back to protogastric region, shallow. Upper

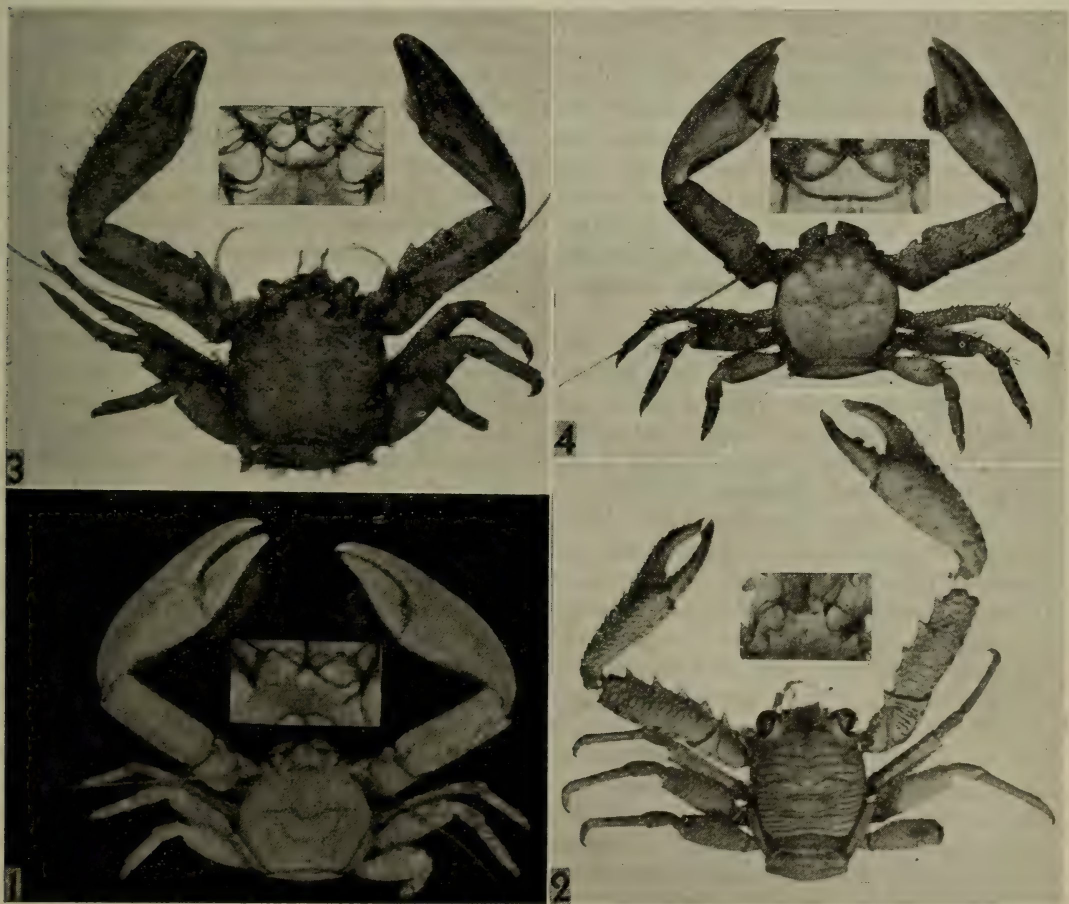
3 4 1 2

FIG. 1.—*Petrolisthes manimaculis*, n. sp., width of carapace 16 mm. FIG. 2.—*Petrolisthes tortugensis*, n. sp., width of carapace 11 mm. FIG. 3.—*Petrolisthes robsonae*, n. sp., width of carapace 8 mm. FIG. 4.—*Petrolisthes cabrilloa*, n. sp., width of carapace 11 mm. Inserts, fourth thoracic sternite.

orbital margin slightly raised, no preorbital spine, postorbital tooth obtuse, right-angled. First movable antennal peduncle armed with a blunt lobe, second peduncle cylindrical, granulated, flagellum compressed, ciliated, twice as long as carapace.

Chelipeds subsimilar, about three times the width of carapace; merus distally armed on inner side with a short, subvertical lobe, not extending forward past inner margin of carpus, surface lightly pubescent; carpus about twice the median width, inner proximal one-fourth with a lamellar lobe, rest of margins subparallel, upper surface granulated and pubescent, a strong posterodistal spine; hands granulated, but not rough, nude, inner margin not distinctly crested or beaded, outer margin smooth, sinuous, undersurface of palm highly polished, lightly punctate; fingers with a tuft of pubescence in gape extending on both fingers for less than half their length.

Ambulatory legs stout; merus of third leg twice as long as wide, pubescent on upper half of outer surface, setaceous on lower; joints of all legs setaceous, no posterodistal spine on meri.

Sexual variation.—Female carapace wider, slope of front more distinct; carpus of cheliped more granulated, inner proximal lobe less distinct. Juveniles with longer pubescence on carapace.

Color in life.—Ground color of carapace dull orange, with striations and numerous spots of very pale greenish white. Margins pale lavender, which becomes darker toward and including the frontal region, where it is dark dusky purple. Antennal peduncles same color as carapace, flagellum ochre with purple edges. Basal segments of maxilliped striated with dull orange and brilliant green; palp brilliant orange. Ground color of carpus green, numerous granulations reddish brown, almost obscuring ground color; hand and finger same color but slightly darker, underside of finger pale, bright, turquoise blue; undersurface of hand much lighter, with green prominent. Merus and carpus of ambulatory legs with patterns and striations light tan to dark brown, propodus with a broad center band of yellowish tan; dactyl with center band of dark brown, tip bright purple, general appearance dark dusky green. Ventral side pale dull yellow with darker patterns on abdomen (Petersen).

Measurements.—The measurements (in millimeters) are given for three specimens, respectively: the holotype male, the allotype female, and the largest female from Morro Bay. Length of carapace 11.4–10.1–12.1, width 11–10.5–13.1; orbital width 6.5–6.3–7.2; rostral width 3–3–3, height 0.9–0.6–1; length of flagellum 24–18–25; of major cheliped, length of carpus 10.2–7.7–9.6, width, proximal 4.8–3.6–5, median 4.2–3.6–4.3; length of hand 19–14.5–17.8, width at base of dactyl 8–6.2–7.6; of minor cheliped, length of carpus 9–7.1–9.5, width, proximal 4.2–3.5–4.8, median 4–3.3–4.3; length of hand 15.3–13–17.8, width 6.5–5.6–7.6; merus of third ambulatory leg, length 6.2–5.2–6.1, width 3.3–3.1–3.5.

Range.—From Point Conception, Calif., to Punta Banda, Baja California, Mexico (approximate).

Material examined.—The type series was taken at Anaheim Landing, Calif., and consists of 10 males and 10 females, some ovigerous.

A single female from Morro Bay, Calif. (see under *Measurements*), collected by the author at low water, February 2, 1939. A series of 50 males and 50 females, from Corona Del Mar, Calif., collected by the author December 9, 1938, low water. A series of 5 males and 5 females, from Malaga Cove, Palo Verde Hills, Calif., collected by Dr. Olga Hartman, February 2, 1939, low water. Also a number of small series of both sexes, taken by the author at the following localities: Point Dume, Calif., January 5, 1939; Topango Canyon, Calif., February 16, 1939; Sesquit Canyon, Calif.; March 4, 1939. All the above contained more than 10 specimens of both sexes. A series of 8 males and 6 females, collected by Paul Rich from the Star and Crescent Pier at San Diego, Calif., February 2, 1939. All the above material is in the author's collection.

Habitat.—Occupies the midtidal zone under shelter of rocks and is more tolerant of sand and muddy water than any of the other California species of this genus.

Remarks.—This proposed species has an affinity with *P. cinctipes* (Randall), 1839, but differs from that species in the following respects: (1) the ambulatory legs have their meri pubescent and setose, instead of nude; (2) the carpus of the chelipeds is twice as long as wide, the proximal lobe small, the margins otherwise subparallel, instead of being one and one-half times as long as wide, margins converging dis-

tally; (3) the carapace is pubescent in juveniles, instead of nude.

Named for Juan Rodriguez Cabrillo, a Portuguese navigator in the service of the King of Spain, who in ill-fitted boats on an uncharted sea discovered a golden empire, and left his bones in an unmarked grave on the windswept island of San Miguel, anno 1542. *Un hombre valiente, saludes.*

Petrolisthes robsonae, n. sp.

Fig. 3

Types.—Male, holotype, and female, paratype, U.S.N.M. no. 79396, collected by Elinor D. Robson from Miraflores Locks, Panama Canal, Canal Zone; March 26, 1937.

Diagnosis.—Carapace lightly roughened, lightly pubescent; front broadly triangular, horizontal; an epibranchial spine. Chelipeds with inner margin of carpus armed with two spines; manus with outer margin concave, spined. Posterodistal end of meri of first and second ambulatories with two spines, upper distal end of carpi with one spine.

Description.—Carapace slightly longer than wide, sides rounding, margin behind the single, sharp, epibranchial spine forming a sharp, indistinctly beaded ridge. Surface very lightly rugose, with or without very light pubescence. Front subhorizontal, slightly advanced, broadly triangular, subentire, a median shallow sinus running back onto the gastric regions dividing the protogastric ridges. The upper ocular margin is lightly beaded, the postorbital tooth a right-angle. First antennal peduncle with a horizontally compressed, distal lobe armed with a single large spine and several smaller spines, the distal end of this lobe rounded and extending past the articulation of the second peduncle, which has a crested ridge, the proximal end the highest. Flagellum nude, two and a half times the length of the carapace.

Chelipeds subequal in the female, differing in the adult male, surfaces lightly roughened with short lines of rugae; merus with an inner distal lobe and a single marginal spine on the upper edge near the outer side; carpus nearly two and a half times as long as wide, subhorizontal on upper surface with a longitudinal median ridge, inner margin armed with two spines, the proximal the largest, the second located in a submedian position, the margin microscopically serrate. In young specimens there is an indication of a third tooth near the distal end, but this is obsolete even in half-grown specimens. Outer margin armed with a sharp, posterodistal spine, a single distal marginal spine, and one or two subdistal outer marginal spines. Manus triangular, rather flattened in the female, rounded in the male, the inner margin revolute, the outer concave and armed with long, sharp-pointed spines extending onto the pollex in the female, ending before the pollex in the male. In addition to these spines there is a fringe of cilia and pubescence covering the outer half of the lower surface of the palm and a dense felt of pubescence extending half the length of the fingers. Major hand of the male with the fingers gaping, blunt, tips not crossing. Minor hand in the male and both hands in the female with fingers approximated for their length, the tips crossing.

Ambulatory legs with their meri lightly crested with pubescence, the remaining joints with sparse setae; a single, sharp, long, flat-lying spine on the upper crest, one-third the distance from the distal end; two spines, one above the other, at the posterodistal end of the meri of the first and second legs. A distal spine on the upper crest of the carpus in all three legs. Propodi in the first two pairs bent forward.

Abdomen heavily fringed between the first four segments. Telson with seven plates, the terminal pair distally separated by a wide V-shaped commissure.

Color in alcohol.—In those specimens on which the pubescence remains the color is a dark brown; in rubbed specimens a distinct pink tone is noted.

Measurements.—Male holotype: length of carapace 8.6 mm, width 8 mm, length of carpus 7.4 mm, width not including teeth 2.8 mm, length of major hand 12.6 mm, width at base of dactyl 5 mm, length of minor hand 12.1 mm, width 4.2 mm, length of major dactyl from joint to tip 4.5 mm, of minor dactyl 5 mm, length of antennal flagellum 21 mm.

Range.—Known only from type locality.

Material examined.—A series of 17 males and 20 females, some ovigerous, all collected at the same time and locality by Mrs. Robson.

Habitat.—Mrs. Robson, after whom the species is named, informs me that it has so far been taken only inside the canal locks during one of their periodic cleanings. It is amazing to me to consider this location as suitable for

Petrolisthes, as I am informed that the water within these locks is continuously being changed, its saline content varying from almost fresh to that of sea water. This change from salt to fresh water argues for an almost unbelievable tolerance on the part of this species to fresh water, a substance lethal to other species of the genus within a short period of time, usually half an hour or more, during which time the membranes are ruptured by osmosis.

Exact information, however, as to the ecology and as to the salinity of the water at the place of capture is not yet available.

Remarks.—This proposed species is allied to *P. armatus* (Gibbes), 1850, but differs from that species in the following respects: (1) by having only two carpal spines, (2) by having only one spine on the upper crest of the meri of the ambulatory legs, (3) by the underside of the hands being half covered with hair, (4) and by the outer margin of the hands being concave and fringed with hair.

This proposed species is dedicated to Mrs. Elinor D. Robson, who has shown a marked interest in the fauna of the Canal Zone.

Petrolisthes tortugensis, n. sp.

Fig. 2

Types.—Male, holotype, U.S.N.M. no. 79395, collected by Dr. Waldo L. Schmitt, at Tortugas, Fla., 8.5 fathoms, July 19, 1924. Three paratypes, 2 males and 1 female, in the author's collection. All other paratypes in the U. S. National Museum (see under *Material examined*).

Diagnosis.—Carapace longer than wide, transversely striate, an epibranchial spine, a branchial spine, lateral margins spined, rostrum obtusely triangular, spined, depressed. Chelipeds long and narrow; upper inner carpal margin 4-spined, lower inner margin with one or two; hands narrow, with spinate outer margins; fingers distorted, with spooned apices, gaping. Ambulatory legs with propodi one-fifth shorter than meri; meri spine crested, numbers 1 and 2 with two posterodistal spines, number 3 with one. Antennal flagellum slender, nonciliate, more than three times carapace length.

Description.—Carapace longer than wide, transversely striate, transversely convex, with an epibranchial spine, a postocular spinule, three lateromarginal, forward- and upward-pointing spines and one on the carapace inside of these and nearer to the third or proximal marginal spine. Rostrum medially depressed, obtusely triangular, and armed on and upon its anterior margin with spines and spinules as follows: an ocular spine, a preocular spine, then two marginal spines, followed by two inner marginal spines, then an upward- and inner-curving spine, and lastly one or two more smaller spines and spinules at the apex. A shallow median sulcus running backward by the subobliterated protogastric lobes. Eyes large and black, their width about one-fifth the carapace length. First movable antennal segment armed on its inner margin with a long, vertically compressed, median spine and a smaller distal spine, the second segment granulous, the third smooth, the flagellum nude, slender, hairlike, and over three times the carapace length.

Chelipeds dissimilar, slender, striate both above and below, their length about three times that of the carapace; ischium armed on its inner ventral margin with a row of three or four spines, the proximal pair the largest; merus with a prominent, sharp spine at its distal, inner, dorsal angle and another below this on the ventral margin, the upper, transverse margin armed with two well-spaced spines; carpus almost three times as long as wide, measured without the spines, its upper surface lightly convex and lacking a longitudinal median ridge, the inner margin armed with four large, sharp-pointed teeth and a distal spinule, their proximal margins longer than their distal, the ventral inner margin armed with one or two spurlike spines on its distal two-thirds, the upper outer margin armed with a row of five short, upward- and forward-pointing spines; the hands dissimilar, that of the major one-third as wide as long, that of the minor one-fourth, their outer margins concave and armed with spinules, the inner margins with light beading, terminating over the base of the movable finger in a sharp spine, the pollices outwardly convex, their tips longitudinally truncate and spooned, the dactylus of the major hand ending in a curved tip that crosses an outer spine on the apex of the pollex, armed on its inner proximal half with two compressed, truncate teeth, which do not engage

the pollex, as in both hands the fingers are widely gaping, the minor dactylus twisted, armed on its upper crest with a row of spinules ending in a falcate tip which crosses the spooned tip of its pollex, its prehensile edge unarmed and the widely spread gape setaceous. The spoon-shaped tips of the fingers with pectinate margins.

Ambulatory legs relatively slender and nude except for a few scattered setae; meri crested with a row of short spines, the distal postero-angle of numbers 1 and 2 are armed with two spines, of number 3 with one spine, in length more than twice their width; the propodi cylindrical, slightly bent, and one-fifth shorter than their meri; the dactyli corneous-tipped and one-half the length of their propodi. Telson composed of 7 segments, in the male apparently formed with 8, the proximal, median triangular portion being transversely divided by a ridge, these two parts, however, coalesced as in *P. galathinus* (Bosc), with which it is associated.

Color in alcohol.—Ground color cream, suffused with rose-pink, especially on all striations and squamae. Ambulatory legs rose-pink, with a median, transverse band of cream on meri and propodi; the distal ends of all segments tipped with cream.

Measurements.—A male paratype, carapace length 6.8, width 6.5; major cheliped 23.5, carpus length 6.5, width without spines 2.4, manus length 10.5, width at base of finger 3.8; minor cheliped, carpus 6, width 2.3, manus 10, width 2.6; first ambulatory leg, length 11, merus 3.7, carpus 1.7, propodus 3.3, dactylus 2; width of eye 1.2; length of antennal flagellum 24 (all measurements in millimeters).

Range.—Known only from type locality (see under *Types*).

Material examined.—A series of 23 specimens: 10 males, 11 females (mostly ovigerous), 2 juveniles. All collected in and around Tortugas, Fla., by Dr. Waldo L. Schmitt, and mostly during the month of June 1931.

Sexual variation.—In the female the chelipeds are much narrower than in the male and are more similar to each other, as in the juveniles of both sexes; however, the dactylus of the major cheliped is the only one of the two which has teeth in the gape.

Habitat.—Taken from *Porites* clumps from extreme low water to a depth of 11 fathoms, mostly from 8 to 11 fathoms.

Remarks.—This proposed species resembles in some respects those placed in the genus *Petrocheles* Miers, in that the lateral margins are spined, the chelipeds long and narrow, the fingers gaping, and rostrum spinate; however, it would seem that there is reason to believe that *Petrocheles* should not have been elevated to full generic standing but left as Miers intended it, as a subgenus of *Petrolisthes*, a course which, from lack of comparative material, I am inclined to follow. It is not allied to many of the American *Petrolisthes*, from all of which it differs in the peculiar spoon-shaped finger tips, reminiscent of a number of forms among the Galatheidae, which in addition display the compressed, truncate teeth that arm the dactylus of the major chela, a character that few if any of the *Petrolisthes* possess.

It is the Atlantic analogue of *P. sanfelipensis* Glassell (Trans. San Diego Soc. Nat. Hist. **8** (21): 281. 1936) from the upper end of the Gulf of California. Both have slender chelipeds, spines on the lateral margins of the carapace, and a spinate rostrum, but the present species differs in that (1) the fingers are spoon-tipped, gaping, and twisted, instead of close-fitting, falcate-tipped, and unarmed in the major dactylus, (2) the line of the rostrum from the ocular spine to its apex is subentire instead of emarginate below the preocular tooth, (3) the inner ventral margin of the carpus of the chelipeds is armed with teeth, instead of being unarmed, and (4) the posterodistal angle of the merus of the third ambulatory leg is spined instead of being unarmed.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

47TH ANNUAL MEETING

The 47th annual meeting of the Academy, held in the Auditorium of the Cosmos Club, January 18, 1945, after the 330th meeting of the Academy, was called to order at 9:45 P.M. by the President, Capt. CLEMENT L. GARNER, with 33 persons in attendance.

The minutes of the 46th annual meeting were approved as published in the JOURNAL 34: 198–205. 1944.

The reports of several officers and of the Committees of Auditors and Tellers were read and accepted. These reports are recorded at the end of the minutes.

After the acceptance of the report of the Committee of Tellers, the President declared the following duly elected to the given offices:

JOHN E. GRAF, *President*
F. G. BRICKWEDDE, *Secretary*
HOWARD S. RAPPLEYE, *Treasurer*
HENRY B. COLLINS, Jr., and JAMES TAYLOR, *Board of Managers to January 1948*

The Secretary presented for the Affiliated Societies their nominations for Vice-Presidents of the Academy as follows:

Philosophical Society of Washington—GEORGE R. WAIT
Anthropological Society of Washington—T. DALE STEWART
Biological Society of Washington—FRANK THONE
Chemical Society of Washington—HORACE S. ISBELL
Entomological Society of Washington—CARL F. W. MUESEBECK
National Geographic Society—ALEXANDER WETMORE
Geological Society of Washington—GEORGE TUNELL
Medical Society of the District of Columbia—FREDERICK O. COE
Columbia Historical Society—GILBERT GROSVENOR
Botanical Society of Washington—FRANK P. CULLINAN
Archaeological Society of Washington—Not functioning for the duration of the National Emergency
Washington Section of the Society of American Foresters—WILLIAM A. DAYTON
Washington Society of Engineers—FRANK B. SCHEETZ
Washington Section of the American Institute of Electrical Engineers—FRANCIS B. SILSBEE
Washington Section of the American Society of Mechanical Engineers—WALTER RAMBERG
Helminthological Society of Washington—MARIO MOLLARI
Washington Branch of the Society of American Bacteriologists—HAROLD R. CURRAN
Washington Post of the Society of American Military Engineers—CLEMENT L. GARNER
Washington Section of the Institute of Radio Engineers—HERBERT GROVE DORSEY
Washington Section of the American Society of Civil Engineers—OWEN B. FRENCH

The Secretary was instructed by the members present to cast a unanimous ballot for these nominees.

The President, Capt. CLEMENT L. GARNER, announced the recipients of the Academy's Awards for Scientific Achievement for 1944 as follows:

In the Biological Sciences to NORMAN H. TOPPING, National Institute of Health, in recognition of his outstanding work in identifying eastern and western types of Rocky Mountain spotted fever.

In the Engineering Sciences, to GALEN B. SCHUBAUER, National Bureau of Standards, in recognition of his distinguished services in aeronautical engineering, particularly for fundamental measurements of turbulence.

In the Physical Sciences, to GEORGE GAMOW, George Washington University, in recognition of his distinguished service in theoretical physics, particularly in the understanding of atomic nuclei and of stars.

The Retiring President, Capt. CLEMENT L. GARNER, appointed Past Presidents HARVEY L. CURTIS and LELAND W. PARR to escort the incoming President, JOHN E. GRAF, to the Chair. After a few brief remarks, Mr. GRAF adjourned the meeting at 10:30 P.M.

The following reports were presented at the meeting:

Report of the Secretary

During the Academy year 43 persons (38 resident and 4 nonresident) were elected to membership. Of these, 25 resident and 1 nonresident qualified for membership, 3 resident and 1 nonresident accepted membership but have not yet qualified by payment of dues, 1 resident and 2 nonresident have not yet re-

plied to the Secretary's notification of election, and 3 persons declined membership. Seven other persons of the 43 elected during the Academy year were elected so recently they have not had time to reply. Seven persons elected to resident membership in the preceding Academy year qualified during the present Academy year just ending. The new members were distributed among the various sciences as follows: 6 in anthropology; 4 in geophysics; 3 each in botany, chemistry and geology; 2 each in mathematics, mechanical engineering, mineralogy, and physics; 1 each in bacteriology, chemical physics, hydrography, ichthyology, paleontology, and geography.

Eight members of the Academy (6 resident and 2 nonresident) having retired from the active practice of their profession were placed on the retired list to enjoy all the privileges of active membership without further payment of dues. Three members (2 resident and 1 nonresident) resigned in good standing. Eight resident members were dropped for nonpayment of dues.

The deaths of the following 13 members (7 resident and 6 nonresident) were reported to the Secretary:

SOFIE A. NORDHOFF-JUNG, Washington, D. C., June 6, 1943.
J. MCKEEN CATTELL, Lancaster, Pa., January 20, 1944.
EDWARD B. MATHEWS, Baltimore, Md., February 4, 1944.
ARTHUR KEITH, Washington, D. C., February 7, 1944.
EDWARD O. ULRICH, Washington, D. C., February 22, 1944.
GEORGE STEIGER, Washington, D. C., April 18, 1944.
ROGER C. WELLS, Washington, D. C., April 19, 1944.
WILLIAM M. CORSE, Washington, D. C., June 3, 1944.
HARRY F. REID, Baltimore, Md., June 18, 1944.
J. FRANKLIN MEYER, Washington, D. C., October 29, 1944.
HARRY V. HARLAN, Sacaton, Ariz., November 6, 1944.
GEORGE W. COGGESHALL, Cambridge, Mass., November 19, 1944.
LYSTER H. DEWEY, Kenmore, N. Y., November 29, 1944.

Of these, ARTHUR KEITH and LYSTER H. DEWEY were original members of the Academy.

On January 17, 1945, the status of membership was as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident......	429	36	2	0	467
Nonresident...	142	26	16	1	185
Total.......	571	62	18	1	652

The net changes in membership during the past year are as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident......	0	+1	0	0	+1
Nonresident...	+7	+1	0	0	+8
Total.......	+7	+2	0	0	+9

During the Academy year 1944 the Board of Managers held 7 meetings, with an average attendance of 20 persons. The following important matters were considered by the Board:

(1) The American Association for the Advancement of Science made available to the Academy during the year a grant of $207.50 for assisting members of the Academy and its Affiliated Societies with research projects in need of funds. This added to the grant of $150 made available in the preceding year makes a total of $357.50 now available to the Academy for assisting deserving research projects. The actual funds remain with the A.A.A.S. until these projects are selected. The Board of Managers voted to receive applications for grants in support of research. The Secretaries of the Affiliated Societies were notified and an announcement was published in the November 1944 issue of the JOURNAL. Applications will be received until February 1, 1945. FRANK H. H. ROBERTS, JR., is chairman of the Committee on A.A.A.S. Grants. Other members of the Committee are: L. W. PARR, R. J. SEEGER, and R. P. TITTSLER.

(2) The Red Book was not published this year because of difficulties arising out of the present emergency. Progress, however, on the publication of the next issue of the Red Book is being made by the Treasurer who has initiated and is preparing a continuing up-to-date list of names with home and business addresses, when both are available, of the members of the Academy and its Affiliated Societies.

During the Academy year, 7 meetings of the Academy were held as follows, beginning with the 324th meeting and ending with the 330th meeting:

On February 17, 1944, LELAND W. PARR, as retiring president, presented an address entitled

Aspects of epidemiology of tuberculosis. (This JOURNAL 34: 169–181. 1944.)

On March 16, 1944, the 1943 Academy Awards for Scientific Achievement were presented to JASON R. SWALLEN, Office of the Coordinator of Inter-American Affairs, for work in the biological sciences; to LLOYD V. BERKNER, commander, U.S.N.R., for work in the engineering sciences; and to LAWRENCE A. WOOD, National Bureau of Standards, for work in the physical sciences.

On April 20, 1944, GERALD FITZGERALD, lieutenant colonel, chief, Aeronautical Chart Service, Army Air Forces, addressed the Academy on *Reconnaissance mapping with trimetrogon.*

On October 19, 1944, J. EDWARD RAUTH, associate professor of psychology, Catholic University of America, addressed the Academy on *The eidetic image.*

On November 30, 1944, ROBERT H. MONTGOMERY, economic adviser, Foreign Economic Administration, addressed a joint meeting of the Philosophical Society of Washington and the Academy on *The impact of technology on community life.*

On December 21, 1944, SCOTT B. RITCHIE, colonel, assistant chief of ordnance, U. S. Army, addressed the Academy on *New developments in ordnance.*

On January 18, 1945, HERBERT FRIEDMANN, curator, Division of Birds, U. S. National Museum, addressed the Academy on *A symbolic goldfinch, a study in medieval ornithology as expressed in art.*

All seven meetings were held in the Assembly Hall of the Cosmos Club.

F. G. BRICKWEDDE, *Secretary.*

Report of the Treasurer

CASH RECEIPTS AND DISBURSEMENTS

RECEIPTS		
From dues 1940......	$ 5.00	
From dues 1941......	10.00	
From dues 1942......	30.00	
From dues 1943......	71.67	
From dues 1944......	2,692.06	
From dues 1945......	35.00	$2,843.73
From life memberships (2)...............		126.85
From JOURNAL Subscriptions, 1940.....	5.40	
From JOURNAL, Subscriptions, 1941.....	11.40	
From JOURNAL, Subscriptions, 1942.....	22.80	
From JOURNAL, Subscriptions, 1943.....	46.20	
From JOURNAL, Subscriptions, 1944.....	353.85	
From JOURNAL, Subscriptions, 1945.....	468.90	
From JOURNAL, Subscriptions, 1946.....	4.05	912.60
From sales of JOURNAL		227.90
From payments for reprints 1943........	122.31	
From payments for reprints 1944........	528.46	650.77
From sales of directory, prior to 1941..	1.05	
From sales of directory, 32d Edition...	0.25	1.30
From interest on investments.........		1,017.25
From check No. 170—"Outlawed".......		21.50
From repayment of withholding on New York City Stock....		4.60
From refund of airmail postage.......		0.70
From overpayment by Shapovalov........		0.35
Total Receipts.....		$5,807.55
Cash balance, Jan. 1, 1944..............		3,028.64
To be accounted for		$8,836.19
DISBURSEMENTS		
For Secretary's Office 1943..............	$ 200.90	
For Secretary's Office 1944..............	87.59	$ 288.49
For Treasurer's Office 1944..............		86.31
For Custodian & Subs. Mgr. 1944.........		62.83
For JOURNAL printing and mailing 1943...	231.68	
For JOURNAL printing and mailing 1944...	2,495.86	2,727.54
For JOURNAL illustrations 1943.........	10.94	
For JOURNAL illustrations 1944.........	223.36	234.30
For JOURNAL reprints 1943..............	66.75	
For JOURNAL reprints 1944..............	531.71	598.46

For Journal office 1943	40.00	
For Journal office 1944	220.00	260.00
For Journal postage, binding & misc. 1943	4.35	
For Journal postage, binding & misc. 1944	22.60	26.95
For Directory 1943		19.50
For Meetings Committee 1943	52.15	
For Meetings Committee 1944	232.20	284.35
For two $1,000 Series G Bonds		2,000.00
For debit memos, refunds, etc.		2.66
Total disbursements		$6,591.39
Cash balance, Dec. 31, 1944		2,244.80
Total		$8,836.19

RECONCILIATION OF BANK BALANCE

Balance as per cash book, 12-31-44			$2,244.80
Bank Balance, Am. Soc. & Tr. Co. as per statement 12-23-44		$2,223.86	
Receipts not deposited		149.67	
		$2,373.53	
Checks outstanding, not cashed			
No. 1018	$ 5.41		
1028	55.20		
1029	51.50		
1030	16.62	128.73	$2,244.80

INVESTMENTS

409 Shares stock of Washington Sanitary Improvement Co., par value $10 per share, cost	$4,090.00
20 Shares stock Potomac Electric Power Co., 6% Pref., cost	2,247.50
4 Certificates Corporate Stock of City of New York, 1 for $500, 3 for $100, cost	800.00
1 Bond of Chicago Railways Co., #1027; interest at 5%, due 1927, par value $1,000, less $250 paid	750.00
2 Real-estate notes of Yetta Kormann et al., dated Oct. 5, 1938, renewed 1941 for 3 years (#7 of 37 for $500 and #8 of 37 for $500), cost	1,000.00
2 Certificates (1 for $4,500 and 1 for $500) Northwestern Federal Savings & Loan Assn. Nos. 1380 and 1441	5,000.00
2 Certificates (1 for $4,000 and 1 for $1,000) First Federal Savings & Loan Assn. Nos. 914 & 1063	5,000.00
7 U. S. Government Series G Bonds at $1,000 each, Nos. M332990G M332991G M332992G M332993G M1808741G M2226088G M2982748	7,000.00
Deposited in Savings Account, American Sec. & Trust Co.	46.87
	$25,934.37
Cash Book balance Dec. 31, 1944	2,244.80
Total Assets	$28,179.17

Total Assets Dec. 31, 1943	$26,962.79
Total Assets Dec. 31, 1944	28,179.17
Increase	$ 1,216.38

The relatively large increase in the assets of the Academy is not actually as large as shown. It is impossible at the close of the fiscal year to know exactly what bills are outstanding. We can not even furnish an exact statement as to the relationship between expenditures and allotments, since, for example, we do not yet know exactly what the charge-to-authors increment of the Journal allotment will be. The statement concerning the status of the various allotments will be submitted later as a supplemental report. It is known, however, that, at the time this report is written, $236.77 has been paid out since January 1, 1945, on obligations incurred in 1944 and chargeable to 1944 expenditures. Also, there are some of the George Banta Publishing Co. bills which have not yet been received. However, making due allowance for this feature, the report shows a healthy increase in the assets of the Academy, which is due, to a considerable extent at least, to the fact that various officers and officials of the Academy have exercised care to keep their expenditures well within their allotments. Perhaps one of the most important single reasons for the increase in assets shown in this report and in the report for the previous year is the fact that we have not issued a Red Book since 1941. The Treasurer's Office is at present at work on a master list which should permit

the resumption of the publication of the Red Book by the latter part of this year or the early part of 1946. It is believed that, under the new arrangements, which are being perfected to expedite the publication of the Red Book, future Red Book costs will be even less than the cost of previous issues in spite of higher printing costs.

HOWARD S. RAPPLEYE, *Treasurer.*

Report of the Auditing Committee

Your committee appointed to audit the accounts and records of the Treasurer for the calendar year 1944 performed that duty on January 11, 1945. Each item of disbursement was found to be duly authorized and supported by a cancelled check or debit memorandum except for the outstanding checks listed in his report. The Treasurer's report, attached hereto, was found to agree in every respect with his records.

The securities listed in his report were examined on January 11, 1945, and were found to be as listed. All unmatured coupons were found attached.

The Treasurer deserves the hearty commendation of the Academy for the careful, systematic, and accurate records which he has kept.

FRANCIS A. SMITH, *Chairman.*
WALTER D. LAMBERT
HARALD A. REHDER.

Report of the Archivist

The archives are stored in Room 113, Soils Building, U. S. Plant Industry Station, Beltsville, Md., in a steel safe, a metal file cabinet, a wooden file cabinet, and two bookcases. The wooden file cabinet belongs to the Academy; the other furniture is borrowed for the duration. No expense was incurred during the year and none is contemplated for the next year.

NATHAN R. SMITH, *Archivist.*

Report of the Board of Editors

Volume 34 of the JOURNAL was somewhat larger than that of the preceding year and showed trends in different directions from those of previous years. Some of these trends are probably not normal or permanent but are connected with dislocations brought about by the war. Volume 34 consisted of 12 issues and contained 416 pages distributed among the sciences and compared with 1943 as shown in the table below.

This volume includes the addresses of the retiring presidents of the Academy and the Philosophical Society as well as an address delivered before the Academy during the previous year. A total of 63 papers was published, which is a slight decline in the number of 65 for 1943. This small loss is offset by the greater length of some of the papers accepted for publication during this year. Of the 63 papers presented 35 or 56 percent were presented by members of the Academy. This represents a small decrease in papers presented by Academy members, a condition that should be corrected.

Volume 34 shows small increases in numbers of halftones and pages. Sixteen halftones and 36 line-cuts appear in the volume. The slight increase in the former was made possible by an increase in appropriation that permitted the Editors to drop the unfortunate ban on free halftones of the last two volumes. Volume 34 contains 28 more pages than appeared in volume 33. This is the most satisfactory trend shown during the year and if possible should be encouraged to continue. The downward trend in number of pages published in the

Sciences	No. papers 1944	No. pages 1944	Percentages by pages 1944	No. papers 1943	No. pages 1943	Percentages by pages 1943
Biological	40	198.2	47.6	56	293.8	75.4
Physical	3	35.9	8.6	7	47.6	12.4
Anthropological	12	105.6	25.4	—	—	—
Geological	5	13.8	3.3	—	—	—
Medical	2	22.5	5.4	—	—	—
Economic	1	2.8	0.7	—	—	—
General	—	—	—	2	17.8	4.6
Obituaries and Proceedings	—	33.2	8.0	—	25.4	6.6
Index	—	4.0	1.0	—	3.4	1.0
Totals	63	416.0	100.0	65	388.0	100.0

Journal at present seems to have been arrested, but it is hoped that the future will see a still more substantial increase in number of pages published.

As would be expected in these abnormal times the war has greatly affected the proportional representation of the sciences in the Journal. The Biological Sciences predominate as they did last year, but they are proportionally much less this year to the other sciences represented. Unlike last year when botanical papers were most numerous, zoological papers (12) are most frequent this year. Botany takes second place with 10 papers and entomological articles are third with 9. Other Biological Sciences represented are: Ichthyology, Mycology, Ornithology, Mammalogy, and Ecology.

Because Chemistry and Physics are closely linked to the war effort, it is not surprising that these sciences are even less well represented in Volume 34 than they were in Volume 33. Inasmuch as the physical scientist's preoccupation with war problems will continue for at least another year, no increase in papers from these sciences can be expected.

Five papers are attributed to the Geological Sciences but these could as well have been placed under the Biological Sciences because they all deal with fossils. Most of the efforts of our geologists in Washington are now directed along lines designed to facilitate the war effort. Consequently the decline in geological papers, which are usually fairly numerous, is understandable.

During the past year an increase of considerable proportions occurred in papers dealing with Man and his activities—Anthropology, Ethnology, Economics, and Medicine. Fifteen papers in these fields constituted some of the most interesting items published during the year and occupied more than 31 percent of the pages published. It is to be hoped that this trend will continue to expand after the war.

Preoccupation with war and generally restricted time account for a decline in published abstracts. The Geological and Botanical Societies, both usually regular contributors, failed to submit their proceedings and abstracts, the latter for at least the third year. The Editors report the publication of 18 obituaries, the largest number to appear for several years.

The year 1944 happily saw little change in editorial policy and what little occurred proved highly advantageous to the Journal and its contributors. A thoughtful increase in the appropriation for the year made it possible to offer authors a full page halftone or its equivalent. Lack of adequate facilities to reproduce illustrations proved a handicap in 1943; it discouraged authors who required halftone illustration. The economies instituted in 1942 continued in force except for the changes relating to halftones and the distribution of 50 free reprints to authors of signed obituaries. The Editors view with considerable satisfaction the fact that it was possible to issue the Journal on a monthly basis, but papers are becoming increasingly fewer and it may be necessary in future to put the Journal on a bimonthly basis on authority voted by the Board of Managers in 1943. This, the Editors believe, would be most unfortunate and they plead with Academy members to give their Journal first consideration in placing their shorter papers. Why should more than 40 percent of the Journal's pages be used by outsiders?

The Board of Managers appropriated to the Board of Editors for printing, illustrating, and mailing the Journal \$3,000; for clerical assistance \$240; and for postage and incidentals \$60, a total of \$3,300. Of this sum the total amount of \$240 for clerical assistance was expended; postage and incidentals (binding volume 33 of the Editors' set of the Journal) required \$25.59. Printing, mailing, and illustrating the Journal cost \$2,981.69. Reprints cost \$592.70. Charges to authors were \$746.51. This sum combined with the original allotment of \$3,000 equals a total available sum of \$3,746.51. Subtracting from this total the \$3,574.39 paid out, a favorable balance of \$172.12 remains. This added to the balance of \$34.41 remaining from postage and incidentals leaves a final favorable balance of \$206.53.

It gives the Editors much pleasure to acknowledge with thanks and appreciation the outstanding assistance to the Journal of Mr. Paul A. Oehser, editorial assistant, whose broad knowledge and experience in editing scientific articles have greatly improved the quality of the Journal. Mr. Oehser has given much wise council and many hours of his own time.

G. Arthur Cooper.
Lewis V. Judson.
Harald A. Rehder.

Report of the Custodian and Subscription Manager of Publications

SUBSCRIPTIONS:

Nonmember subscriptions in the United States	107
Nonmember subscriptions in foreign countries	35
Nonmember subscriptions in enemy-controlled areas (inactive)	25
Subscriptions, Geological Society of Washington	12

INVENTORY OF STOCKS AS OF DECEMBER 31, 1944:

Reserve Sets of the JOURNAL:	
Bound Volumes 1–29 and unbound Volumes 30–34	1 set
Unbound Volumes 1–34	4 sets
Unbound Volumes 11–34	6 sets
Unbound Volumes 16–34	11 sets
Proceedings of the Washington Academy of Sciences:	
Volumes 1–13, inclusive	50 sets

In 1939 the Board of Managers directed the Custodian of Publications to set aside a specific number of volumes of the JOURNAL to be sold only as complete sets. This order states: Eight (8) complete sets from Vol. 1 to current volumes (34); Six (6) additional sets from Vol. 11 to current volumes (34); Eleven (11) additional sets from Vol. 16 to current volume (34). These volumes should constitute the reserve sets. Since 1939 five reserve sets from Vol. 1 to the current number have been sold. Three of these sets were sold in 1944. When disposing of back numbers of those of deceased members, some of our members have turned them over to the Custodian of Publications, which enabled him to assemble two complete sets from Vol. 1 to the current number. During the coming year an effort will be made to obtain by gift or purchase some of the early numbers now missing from the miscellaneous series in order to assemble additional reserve sets.

A miscellaneous series of volumes and separate numbers of the JOURNAL, consisting of approximately 18,000 numbers, is maintained for sale. Complete sets of the Proceedings of the Academy Vols. 1–13 (1899–1911), together with Directories, are also available.

Most of these volumes, including five reserve sets from Vols. 1–34, are stored without cost to the Academy in the Smithsonian Institution and the U. S. Coast and Geodetic Survey. Some of the volumes from Vols. 23–34 are stored by the George Banta Publishing Co. at Menasha, Wis.

SALES AND EXPENDITURES:

During the year 1944 three reserve sets were sold. These were purchased by libraries at the following universities: Notre Dame, New Mexico, and Mississippi. These were shipped via express, prepaid.

SALES

3 reserve sets	$504.00
Net sales of miscellaneous numbers	69.93
Total sales	$573.93

EXPENDITURES

2-year supply of postage and envelopes	$ 31.94
Express charges for shipments of 3 reserve sets of the *Journal*	20.89
1 year clerical assistance	10.00
Total expenses	$ 62.83
1944 Budgetary allotment	50.00
Excess over 1944 budget allotment (due to express charges)	12.83
Net gain for the year 1944	$511.10

FRANK M. SETZLER, *Custodian and Subscription Manager of Publications.*

Report of the Committee of Tellers

A total of 231 envelopes were delivered to the Committee by the Secretary. Of these, all bore a signature and each contained a ballot.

The count of ballots for officers of the Academy showed the following elected:

President, JOHN E. GRAF
Secretary, F. G. BRICKWEDDE
Treasurer, HOWARD S. RAPPLEYE
Board of Managers to January 1948, HENRY B. COLLINS, JR., and JAMES H. TAYLOR.

G. R. WAITE, *Chairman.*
W. D. URRY
C. A. WHITTEN.

Submitted by F. G. BRICKWEDDE, *Secretary.*

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This Journal is Indexed in the International Index to Periodicals.

Vol. 35 August 15, 1945 No. 8

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

PUBLISHED MONTHLY
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at Menasha, Wisconsin

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Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued monthly, on the fifteenth of each month. Volumes correspond to calendar years.

Manuscripts may be sent to any member of the Board of Editors. It is urgently requested that contributors consult the latest numbers of the JOURNAL and conform their manuscripts to the usage found there as regards arrangement of title, subheads, synonymies, footnotes, tables, bibliography, legends for illustrations, and other matter. Manuscripts should be typewritten, double-spaced, on good paper. Footnotes should be numbered serially in pencil and submitted on a separate sheet. The editors do not assume responsibility for the ideas expressed by the author, nor can they undertake to correct other than obvious minor errors.

Illustrations in excess of the equivalent (in cost) of one full-page halftone are to be paid for by the author.

Proof.—In order to facilitate prompt publication one proof will generally be sent to authors in or near Washington. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Unusual cost of foreign, mathematical, and tabular material, as well as alterations made in the proof by the author, may be charged to the author.

Author's Reprints—Reprints will be furnished in accordance with the following schedule of prices (approximate):

Copies	4 pp.	8 pp.	12 pp.	16 pp.	20 pp.	Covers
50	$2.00	$3.25	$ 5.20	$ 5.45	$ 7.25	$2.00
100	2.50	4.00	6.40	6.75	8.75	2.75
150	3.00	4.75	7.60	8.05	10.25	3.50
200	3.50	5.50	8.80	9.35	11.75	4.25
250	4.00	6.25	10.00	10.65	13.25	5.00

Subscriptions or requests for the purchase of back numbers or volumes of the JOURNAL or the PROCEEDINGS should be sent to FRANK M. SETZLER, Custodian and Subscription Manager of Publications, U. S. National Museum, Washington 25, D. C.

Subscription Rates for the JOURNAL.—Per year........................$ 6.00
Single numbers.. .50
Limited number of complete sets of the JOURNAL for sale.
Single volumes, unbound, per volume........................ 6.00

PROCEEDINGS, vols. 1–13 (1899–1911) complete........................ 25.00
Single volumes, unbound.. 2.00
Single numbers.. .25

Missing Numbers will be replaced without charge provided that claim is made to the Treasurer within 30 days after date of following issue.

Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. S. RAPPLEYE, U. S. Coast and Geodetic Survey, Washington 25, D. C.

Exchanges.—The Academy does not exchange its publications for those of other societies.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

Volume 35 | August 15, 1945 | No. 8

ETHNOLOGY.—*The Wesorts of southern Maryland: An outcasted group.*[1] William Harlen Gilbert, Jr.,[2] Library of Congress.

The Wesorts are a people of mixed racial origin who live in parts of southern Maryland (Semmes, 1944, p. 6; Speck, 1922, p. 11; Weslager, 1943, pp. 156, 158). The origin of their name, as well as of the people themselves, is shrouded in mystery. It would appear that they are mainly of white and Indian blood with an occasional strong infusion of the Negro element. The distribution of these people is rather limited, being confined to Charles County and the adjacent parts of Prince Georges and St. Marys Counties. No accurate data have been secured on their numbers in the various communities and neighborhoods of this area. Because of their location in close proximity to Washington, D. C., a number of them have migrated in that city. Nowhere, either in Charles County or the other counties, do the Wesorts constitute more than a small fraction of the general population, which is almost evenly divided in numbers between the White and Negro races.

The origin of the name "Wesort" has been explained in several ways. The most simple and plausible theory attributes the origin to the phrase "we sorts are not the same as you sorts," which was employed by them in speaking to the Negroes of the area (White, 1939). This idea seems to accord with the dominating motif of Wesort existence, namely, a desire to be held a distinct race from the Negro. In this connection it might be noted that the birth certificates and marriage licenses issued to these people generally have the race indicated as "Colored-Wesort." The name "Wesort" has been employed among these people as far back as 1900 and possibly for 10 to 20 years before that date, as we shall see.

A second theory attributes the origin of the name to a corruption of an Algonquin term "witchott," which is said to mean an oval house of bark. No source is given for this word or any evidence for the change into Wesort (Maynard, 1941, p. 76). A third theory might be advanced with more credibility that the term is derived from the word "Wisoes," which was used to denote the peace councillors of the early Algonquin tribes in southern Maryland (Writers' Program, 1940, p. 20). This view might be reinforced by the suggestion that the Indians who survived in this area were the friendly or peaceful tribes, who were later called Doeg Indians. On the other hand, when the early date of disappearance of Indian languages in Maryland is considered along with the comparative recency of the use of the term "Wesort," it hardly seems possible that the aboriginal name should have survived without some notice.

Concerning the origin of the Wesorts there are again several theories. All these admit the presence of an Indian element in the Wesorts, but they differ as to their explanation of the White or Negro elements. One hypothesis attributes the White or non-Indian blood to escaped indentured

[1] Received May 10, 1945.

[2] The helpful suggestions and communications from the following persons have been, among others, of the greatest assistance in the compilation of materials for this paper: Dr. Daniel S. Fisher, Maryland County Health Officer for Charles County at La Plata; H. Holland Hawkins, resident of La Plata; Philip S. Proctor, of the U. S. Bureau of Internal Revenue, Washington, D. C., a Piscataway Indian and former resident of Popes Creek in Charles County; and the Rev. Herman I. Storck, of St. Ignatius Church, St. Thomas Manor, Chapel Point (Bel Alton P.O.), Charles County.

servants who fled to the swamps and frontier to live with the Indians during the earlier colonial period (communication from Dr. Daniel S. Fisher). Another guess attributes the non-Indian blood to Spanish sailors wrecked on the shores of early Maryland at an unknown date (Warner, 1939). It is worth while to note that dark complexion in several mixed groups of the eastern states, the Melungeons of Tennessee, the Moors of Delaware, the Turks of South Carolina and the Cubans of North Carolina, is attributed by these people themselves to Latin or Mediterranean origins which helps to avoid what they consider the stigma of possible Negro crossing. A similar notion is represented in the theory that French-Canadian traders intermarried with the Indians of Port Tobacco in the seventeenth century and sired the Wesorts. This theory might explain the religion but hardly the English family names of these people.

The origin of the Indian element in the Wesorts is explained by the great number of friendly Indians who were gradually converted to Roman Catholicism by Father White and his coworkers and who were settled in reservation areas in western Charles County during the colonial period (Semmes, 1937, p. 303; N. Y. Times, Mar. 19, 1940; Writers' Program, 1940, p. 21). At the time of the earliest discovery in the seventeenth century there were, along the Potomac shores of Maryland, a number of small streams and swampy tracts that were the habitats of individual tribal groups bearing the same names as these water courses (Semmes, 1929, pp. 195–209). Thus we find in St. Marys County the Chapticon and the Wicomico (Secowocomoco) along the Chaptico and Wicomico Rivers; in Charles County the Zekiah (Za, Pangayo, or Saco) along the Zekiah Swamp, the Potopacs of Port Tobacco, the Nanjemoy of Nanjemoy Creek, the Chicamuxen and Pomonkey along creeks of the same name, and the Mattawoman of the upper Mattawoman Creek; in Prince Georges County the Piscataway of Piscataway Creek and the Patuxent along the middle course of the Patuxent River; and in the District of Columbia the Iroquoian Anacostans along the Anacostia River. Of these the Piscataways held themselves to be the natural leaders and somewhat above the rest. In the course of colonial Indian wars the Piscataways were expelled from Maryland and only a few families survive in the State today, at Point of Rocks south of Frederick, and at one or two other points. The fate of the other tribes is not yet well known.

The location of the early Indian groups in southern Maryland was naturally conditioned by the means of subsistence in terms of local topography. Communication was almost entirely by canoe and along the streams or bays which led inland from the sea. There may have been some use of the inland higher ridges for occasional hunting or for corn and tobacco raising. In the main, however, Indian settlements were in or near swamps and streams where game was easy to find and defense from northern marauders was more effective. Apparently each stream and swamp constituted the hunting area of some particular Indian group which excluded outsiders. The still surviving early St. Ignatius Church at Chapel Point well illustrates in its location the importance of water travel in early Maryland for both Whites and Indians. This Church is situated on a prominent headland on the Potomac, easy of access by water from various parts but at a distance of two miles from the main axis of present-day settlement at Bel Alton.

Today the communications in southern Maryland are primarily by land and the chief roads tend to follow the ridges or highest ground between streams. This in turn has affected the distribution of both White and Wesort farmsteads. The farms are located along the main north and south highways and the branch roads from these. The main concrete road through Charles County today is United States Highway No. 301, and this seems to be the main axis of Wesort settlement from Upper Marlboro, the county seat for Prince Georges County, in the north to Faulkner or Lothair in the southern part of Charles County. The roads of today, which mark out the ridges between streams, would serve as the boundaries of the ancient tribal areas which centered in the streams themselves. It has been said that some of the Wesorts of

Allen's Fresh at the mouth of Zekiah Swamp still assert that they are of the Za tribe, while those to the west along Nanjemoy Creek claim descent from the Nanjemoy Tribe.

The Whites and Negroes of Charles County have their own neighborhood and community groups (Dodson and Woolley, 1943). The following community groups or neighborhoods may be said to include the chief Wesort locations in Southern Maryland: (1) In Prince Georges County there are (a) "Proctorville" near Cedarville, (b) the Thompsons near Brandywine, and (c) the Swans near Croom; (2) in Charles County there are (a) Pomfret to the northwest of Port Tobacco, (b) La Plata, the county seat, (c) Port Tobacco, southwest of La Plata, (d) Waldorf and White Plains, north of La Plata, (e) Glymont and Indian Head on the Potomac near the mouth of the Mattawoman Creek, (f) Pamonkey east of Indian Head, (g) Hill Top and Pisgah south of Indian Head, (h) Bel Alton and Chapel Point, south of La Plata, (i) Faulkner (Lothair), south of Bel Alton and including Diggs Crossing, (j) Popes Creek south of Faulkner, and (k) Allen's Fresh at the mouth of Zekiah Swamp. The Wesort neighborhoods in the Chaptico Creek area of western St. Marys County are not yet ascertained.

On the outskirts of the settlements such as those immediately south of Waldorf on Highway No. 301 one can pass both Negro and Wesort dwellings in driving through. In the District of Columbia one of the first parts to be reached by migrating Wesorts would be Anacostia where we find them interspersed with the Negro sections. Possibly other centers of settlement are in the Negro sections of the northwest Washington near Georgia Avenue.

The present number of Wesorts in southern Maryland is open to free estimation. The United States Census classifies them as Negroes and makes no separate enumeration. According to one source there are several hundred members of this group, while a second ventures the more specific figures of anywhere between 750 to 3,000 persons (Semmes, 1937, p. 503; N. Y. Times, Mar. 19, 1940). The St. Ignatius Church at

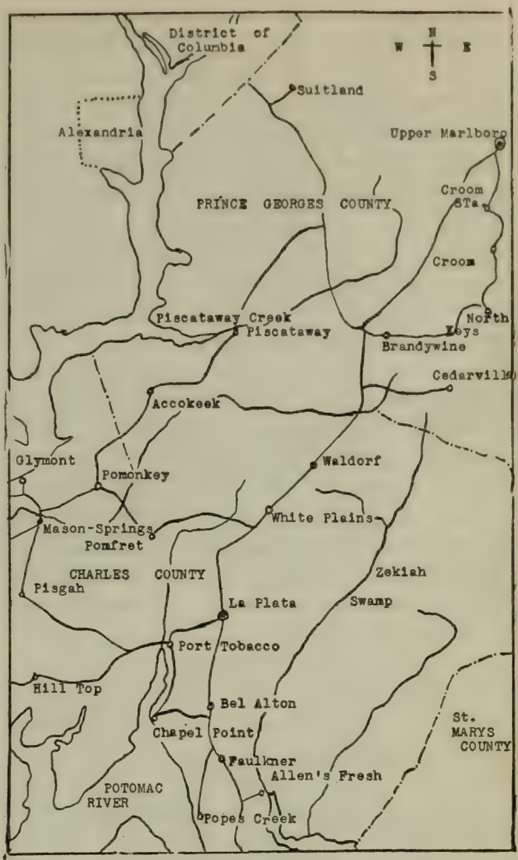

Fig. 1.—Map showing the principal points in the Wesort country of southern Maryland.

Bel Alton has a total congregation of over 850, and of these it is possible that Wesorts number 175 to 200. Since the total population of the Bel Alton area is around 1,000 persons, it is possible that the Wesorts may constitute as much as 20 percent of that number. An accurate census of the Wesort population by a house-to-house canvass would go far toward clearing up certain basic problems of identity and relative strength of numbers. It is to be hoped that the Census Bureau, with its keen appreciation of statistical needs, will in the Census of 1950 tackle this problem on its own doorsteps, so to speak, as well as it has that of enumerating the Croatans in North Carolina. We shall have occasion to refer to the great value of even indirect Census data in a later connection in this paper.

The physical traits of the Wesorts, as might be expected in a mixed group, are

quite variable. Within the same family one can see children who are blond and blue-eyed, children with the bronze skin and straight black hair of the Indian, and still darker children with the very curly or semi-frizzled hair of the Negro (Footner, 1942, p. 357; Graham, 1935, p. 10; Hodge, 1914, p. 17). The prevailing theory among the neighboring Whites is that mulatto blood is widespread among the Wesorts. Most of them agree, however, that for a long time the Wesorts have been marrying among themselves, with even first-cousin marriage being by no means rare. This would seem to place the introduction of Negro blood to occasional entries in the past or to recent mulatto or other mixed blood. At any rate, inbreeding, in the absence of any environmental or religious isolation, would seem to emphasize the racial-purity sentiment and demonstrate the existence of the fear of absorption by the Negro. The fact that the local Whites appear to be of Old American stock and quite preponderantly blond helps to indicate the source of mixture when it appears among Wesorts.

It is thought by local White observers that the Wesorts have degenerated greatly in physical fitness because of their inbreeding. Among other traits said to have developed among the Wesorts are albino skin and hair, early deafness, palsy and nervousness, epilepsy, bandy legs, near blindness, toothlessness, and stuttering speech. Idiocy and dull-wittedness are also said to occur all too frequently among them. Yet we have the contradictory observation of others that Wesorts are quite normal in mental faculties and even occasionally very bright. The Wesort young women are conceded by these observers to be very frequently rather pretty and attractive even from their own (i.e., the White) point of view. It is said that Wesorts prefer to marry out into the White group and that those who marry Negroes are ostracized from their ranks. Owing to the Maryland law against racial intermarriage between Whites and Negroes (and Negro cross breeds to the third generation) it is doubtful whether legal unions can be contracted between Wesorts and Whites.

Early marriages are the rule among Wesorts, and large families of eight to ten children are frequent even today. In the absence of figures on infant mortality it is not possible to say that the population of this group is rapidly increasing, although it might be expected. The extent of the migration outward to Washington, D. C., Baltimore, and Pennsylvania must be a factor to be kept in mind also.

The Wesorts are practically 100 percent Roman Catholics in religion; however, this does not mark them off from their neighbors since both the Whites and Negroes of this part of Maryland are mainly of the same faith.

The school question is perhaps the greatest stumbling block for the Wesorts. Illiteracy is widespread among the older generation, and this is said to be due to their having refused to attend Negro schools in their youth. It is also said that a few years ago some of the younger generation of Wesorts attempted to enter White schools but upon discovery were forced out. Some now attend the Negro schools, as for example at Bel Alton, but it is doubtful whether this constitutes a majority of the Wesort children.

The local Whites assert that the older generation of Wesorts are honest, reliable, industrious, and good humored but that many of the younger generation have been ruined in their morals since the bootlegging period under the national Prohibition Law of 1919–1933. A number of these younger persons are said to be outlaws and ne'er-do-wells.

The occupation of 90 percent of the Wesorts is farming, farm labor, or domestic employment. They are also accounted able hunters, guides, and fishermen. Only a few, however, own their own farms. The vast majority are poor rural folk, but they are said never to apply for public relief even though they may be in the worst of straits. The local Whites account them as excellent farm tenants and farm workers but say that they are very proud and will not hire out where they are expected to mingle with the Negro help. In serving meals to the Wesort hired help separate tables must be used so that they do not sit down with Negroes.

FIG. 2.—Photographs of Wesort families and individuals showing divergent racial types.

The Wesorts are distinguished by certain family names which are more or less peculiar to them in the area in which they live. These names are Butler, Frazer, Gray, Harley, Hensley, Hollis, Holly or Holley, Linkin or Lenkin, Marshall, Mason, Mathews, Newman, Neale, Penny, Perry, Proctor or Procter, Queen, Richmond, Savoy, Simmonds, Swann or Swan, and Thompson. As we have already stated, these names occur in public records of marriages, births, etc., with the race designation "Colored-Wesort." Some of these names may also be family names of nearby Whites and Negroes, but none of the Wesort families ever seem to stray from the fixed list mentioned above. In order to distinguish the various families of the same name the qualifying word "set" may be used. Thus the set of Proctors in Bel Alton is different from the set in Prince Georges County. There seems to be no aversion for a man to marry a girl of the same family name.

Documentary evidence of the growth of the use of the term "Wesort" in connection with certain family names is afforded at the St. Ignatius Church at Bel Alton (communication from the Rev. H. I. Storck). The earliest practice during the 1880's was to designate the race of persons baptized in the parish records as either "White" or "Colored." Abbreviations for Latin terms such as "Nig." (for Latin *niger*, black) and "Alb." (for *albus*, white) were also used to the same purpose. The first occurrence of the term which designates a third race was in the case of a person baptized in August 1896, in which the race was designated as "We-sort." In the years 1899, 1901, and 1902 this term recurs with increasing frequency and always in connection with family names such as Butler, Harley, Linkin, Mason, Newman, Proctor, Savoy, Swann, and Thompson. Also in connection with these family cognomens it might be noted that the race of a person with a Wesort family name baptized in November 1889 was designated as "Yellow" and the same term recurs a few years later in a baptism of September 1896. Apparently each priest employed his own method of indicating the three different racial groups, as for example in the case of one who employed the designation "(Col) Wesort" or another who distinguished "White," "Nig.," and "Col." and by the context of the family names doubtless meaning Wesort by the latter term. Thus it seems a racial entity gradually creeps into recognition until at the present time Wesort has become an accepted term in the parish records for members of these family groups.

What can be said concerning the origin of this distinct set of English patronymics in a mixed population? Some attempt has been made to connect them with preexisting Indian names; e.g., Swann has been linked with Wannys, a name of several early chiefs in southern Maryland and even with Shawnee, which tribe had early representatives in Maryland. Probably, however, these names are simply derived from the white men, whose union with Indian women gave rise to this mixed group. In addition, it is to be noted that the early Jesuit missionaries gave English names to their Indian converts. Each of the other mixed groups in the eastern States, the Croatans, Nanticokes, Cajans, etc., have distinct sets of family names peculiar to themselves and probably of similar manner of origin.

In connection with their family names we have another line of evidence regarding the origin of the Wesorts. The first United States Census was taken in 1790 and included a list of the family names of heads of families in the various states and counties together with indications as to whether they were Whites, free Negroes, mulattoes, or slaves (Heads of Families, 1790, Maryland). The data are presented by counties and in the table for Charles County, Md. we find the "mulatto" heads of families bearing most of the family names which are found among the Wesorts today with other additional names as well. About 54 family names are to be found in this group including Butler, Harley, Linkin and Lenkin, Newman, Proctor, Penny, Swann, Savoy, and Thompson. All these family names, with the exception of Harley, appear also somewhat earlier among the White population of Charles County in the Constable's Census of that County of 1775–1778 (Brum-

baugh, vol. 1, pp. 297–312). So it is likely that the Wesort family names were derived from local White names sometime during the eighteenth century or possibly even earlier (Charles County was first settled in 1642) and were borne first by the "mulatto" or free Negro population of Charles County. Up to the time of the Civil War the free Negro population of Charles County is listed separately in the census statistics from the White and slave groups. It is probable, then, that in the statistics of the growth of the free Negro group some idea may be gained of the relative growth of the early ancestral Wesort population. The total number of Charles County mulattoes listed under family name groups in 1790 was 357, although the census of 1790 officially tabulates 404 free Negroes in that county. The growth of the free Negro population in relation to the other elements of the population may be seen from the following table compiled from the census records.

Table 1.—Charles County, Md., Population by Race, 1790–1860

Year	Whites	Free Negroes	Slaves	Total
1790	10,124	404	10,085	20,613
1800	9,043	571	9,558	19,172
1810	7,398	412	12,435	20,245
1820	6,514	567	9,419	16,500
1830	6,789	851	10,129	17,769
1840	6,022	819	9,182	16,923
1850	5,665	913	9,584	16,162
1860	5,796	1,068	9,653	16,517

The Census of 1870, owing to the freeing of the slaves during that decade, shows a free Negro population of 9,318 and thus can no longer be said to include primarily the Wesort ancestral group. It would seem that the Civil War, by obliterating the distinction between free Negro and slave in Charles County, stimulated the former group to invent a term to designate themselves as a distinct group, namely "Wesort." According to a tradition among these people, it was "Aunt" Sallie Ann Thompson who invented the term Wesort by constantly using the expression "we sort of people" about 1882. This was taken up by her kinsmen and neighbors and gradually spread to the entire county and beyond. If the rate of growth of the numbers of the free Negroes as indicated here continued we should expect to find around 1,900 of these people in Charles County by 1940. The following table illustrates the growth of the White and Negro population of the county since 1860.

Table 2.—Charles County, Md., Population by Race, 1870–1940

Year	Whites	Negroes	Total
1870	6,418	9,318	15,738
1880	7,700	10,848	18,548
1890	7,054	8,137	15,191
1900	8,014	9,648	17,662
1910	7,813	8,572	16,386
1920	9,495	8,210	17,705
1930	8,674	7,492	16,166
1940	10,384	7,228	17,612

The variability of the figures in the above table is interesting. It would suggest the possibility, at least, of the Wesorts being included in some censuses as White and in others as Negro. The large rise in Negro population in 1880 and the rise of the Whites in 1940 are cases in point. Only a detailed examination of the family names in the census schedules would indicate if this were true or not.

Turning now to the social status of the Wesorts we find a most interesting situation. Their own opinion, backed to a considerable extent by that of the local Whites, is that they constitute an intermediate caste between the White and the Negro. This is so because they refuse to be identified with Negroes yet are unable to find acceptance as social equals by the Whites. They do not decry any union of members of their group with Whites as they do those unions with Negroes. The local Negroes are inclined to belittle the pretensions to superiority which they feel are unwarranted in the Wesorts. The Whites look more favorably upon the Wesorts as reliable workers than they do upon the Negroes but are inclined to dislike the Wesorts because of degenerate traits which they ascribe to inbreeding.

The Wesorts would seem to indicate how it is possible for physical traits to result in a type of group consciousness. Keenly aware that their racial type is not that of the typi-

cal Negro they attempt to avoid those situations that classify them as Negro. "We are the Yellow People and we are different from the Negro" is the way H. S., of Bel Alton, one of the older and much respected members of the community, expresses the idea. To cite the words of another of the older and respected members of this group, L. T., of White Plains "I was born a Wesort and I am going to die a Wesort." Such a clear and simple confession of faith can hardly be disregarded by the social psychologist because it so well illustrates the "we-group" feeling so ably defined and discussed by such eminent sociologists as William Graham Sumner and Charles Horton Cooley.

The Wesorts appear to have isolated themselves from the Negro in a variety of ways. They will not eat with them at the same table, or sleep at their homes, or permit Negroes to attend their dances. Yet they seem to regard it as proper to appear at Negro recreational affairs such as picnics and outings, participating in a kind of standoffish way. White people, on the other hand, may attend Wesort funerals, weddings, and dances.

Patterns of triracial or three-way segregation are well illustrated at St. Ignatius Church at Chapel Point (Dodson and Woolley, 1943, p. 297). Here, for many years, the seats in the main body of the Church are reserved for White people, while there is a separate section in the back for the Wesort members. In addition there is a gallery running along the sides of the Church which is generally occupied by Negroes, although occasionally these people come down and sit in the Wesort section when it is not occupied. Negroes formerly used a separate door from that used by the Whites and Wesorts.

Also illustrative of the segregation principle is the ancient cemetery located just outside the church on a scenic knoll overlooking the Potomac. The grave markers around the top of the bluff near the church and for some distance downward are those of White people. The lower part of the hill constitutes the Negro section of the cemetery in which Wesorts and Negroes are buried.

It is said that formerly Wesorts were accustomed to occupying seats in busses and carriages behind the Whites but ahead of the Negroes. The same is asserted to have been true of seating in motion-picture houses. One informant tells of hunting and fishing parties made up of male members of the three races at which the whisky jug would be passed around first to the Whites, then to the Wesorts, and finally to the Negroes.

As a buffer group between the Whites and the Negroes the Wesorts have absorbed some of the shocks of racial conflict and provided a cushion to soften the process of miscegenation. One gains the impression that we have here a basically Indian group that has been gradually getting whiter through greater and greater amounts of White blood yet presenting Mendelian segregations of physical traits that recall the original Indian type. Into this mixture have apparently been introduced mulatto, quadroon, or octoroon elements.

Politically the Wesorts participate to a greater degree than the Negro in the local affairs. They vote freely and, like the traditional Negro voters, are mainly Republican by party affiliation. Like the Negroes they do not hold public office in the county. The White people of this area are mainly Democratic in party affiliation.

Two instances illustrative of the practical difficulties attending the triracial situation might be cited here. In the present World War the local draft boards have been hard put to it in classifying the Wesorts for service with the armed forces. Some have been sent into Negro battalions, while others, have been sent into White, and it is probable that some have not been inducted at all because of the difficulties attendant on their racial classification. Thus, as a result of their racially in-between position, the Wesorts have suffered an uncertainty of both present and future status. This is still further illustrated in the case of some Wesorts who located in Washington, D. C., and in view of the housing shortage wanted to locate in a district from which they were barred by the owners because of color restrictions. These Wesorts sent back anxious inquiries to their parish

priest for records to be used as proof that they were not Negroes. We are not told how they finally came out in this search for status.

What happens to the Wesorts who migrate to the city? The answer to this question would be of the greatest assistance in understanding the nature of the attitudes and barriers that interpose themselves to the absorption of the Wesorts into the general population. At present the question can not be answered but the following suggestions might be made. A study of the family names in the city directories of Baltimore and Washington would be one clue. The Baltimore City Directory from 1812 to 1923 designates its Negro population separately from the White and we find Wesort family names beginning to occur among the Negro classification far back in the nineteenth century. Similarly, the Washington, D. C., city directory indicates the Negro population separately from 1850 to 1873. During this period and after, the Wesort family names occur with increasing frequency. A follow-up study of the addresses within the cities mentioned of persons with Wesort family names and of their location with reference to White, Negro, and foreign-born areas would help still further to indicate what becomes of the urban Wesort.

What then, for practical purposes, is a Wesort? This may be answered in a general definition as a person of mixed Indian and White and possibly Negro blood who has a Wesort family name and who lives in or derives from Charles, Prince Georges, or St. Marys Counties in southern Maryland. Admittance to the Wesort category may be by birth or, as an Indian, White, or light mulatto outsider, by marriage to a Wesort.

Little remains today of the Indian heritage among these people. In fact, there seem to be no unifying cultural traits to bind them into a common unity distinct from Whites and Negroes. There are no clubs or organizations peculiar to Wesorts. They are said, however, to celebrate an annual feast day on August 15, the day of the Assumption of the Blessed Virgin Mary, which commemorates her death and miraculous ascent into heaven. This date is said to be celebrated by feasting, visits, ball games, and dances. It is also asserted that the local White Catholics do not celebrate this occasion with such emphasis. The date and seasonal timing recall the Green Corn Festival which is so widespread and important to all the Southeastern Indians and perhaps in this respect it might constitute a survival of that rite. Also peculiar to Wesorts were several baseball teams which in former years were organized by neighborhood groups and played games in a Wesort league.

Although nothing has been reported in the meager literature on the Wesorts it is quite possible that various elements of both material and nonmaterial culture, peculiar to themselves, may still survive. It is said that medicine men or native herbalists still survive at Allen's Fresh and Pomonkey and that these individuals still make arrowheads and can recount Indian traditions. Survivals in groups of this type of fish and animal traps, basketry, gourd cups, and carved wooden objects are not in themselves of much significance insofar as Indian origin is concerned. Of greater value might be their ecological linkage with such local features as the Zekiah Swamp and the old hunting territories of the Algonquins. The survival of primitive racial groups where alien invaders have mostly displaced their neighboring kinfolk may quite frequently be attributed to isolating ecological peculiarities such as swamp economy or mountain habitat.

In fact the position of the Wesorts is made much clearer if we consider them in the perspective of Indian survival groups generally on the Atlantic coast from New England to Louisiana. Many of these groups have Indian tribal names, while some like the Wesorts do not. To the north in the rugged Ramapo range between New Jersey and New York are the Jackson Whites, a mixed Indian-White-Negro group set off by topographic factors. Farther south in southern New Jersey and northern Delaware are the Moors, who, like the Wesorts, are possibly survivals of mixed Indian and white swamp dwellers of colonial times. Similar Coastal Plain swamp mixed groups occur in Virginia, North and South

Carolina, and Florida, whose names are numerous (Brass-ankles, Red-bones, Croatans, etc.) and whose separate identities have never yet been seriously studied. Like the Wesorts they do not know anything of their origin, yet hold themselves aloof from the Negro even while repulsed by the Whites. As in the case of the Wesorts they are often thought of by the White as mulattoes. Like the Wesorts again they are often thought by the Whites to be bootleggers and possible outlaws as well as good farmers and hunters. To the westward of the Coastal Plain in the Appalachian Mountains are similar groups such as the Melungeons of Tennessee and the nearly related if not identical Guineas of West Virginia.

Since many of these racial islands are occasionally visited by the western Indians and recognized by them as their coracials it has been proposed that the degenerative inbreeding of such groups as the Wesorts be compensated for by bringing in fresh blood from the larger western groups.

The Wesorts are part of this pattern of the partially assimilated aborigines not only in the United States but of the world over. In the Far East the Miao groups of southern China, and in India the pariah outcastes or untouchable groups and hill tribes all exemplify similar cases of nonassimilation and ethnic groups or minorities that have been discriminated against. A close study of the Wesorts as a type of the outcasted group should go far toward explaining the factors that are part of the world-wide impact of Europeans and their culture upon the native colored peoples of an alien tradition.

What practical policies have there been on the part of the White man in dealing with minorities of this type in the United States? It might be noted that the trend in recent years has been toward a recognition of such racial minorities in the form of separate schools and provision for corporate organization and community cooperation. Such triracial recognition has been granted the Croatans of North Carolina and to some extent to the Cajans of Alabama and Nanticokes of Delaware. Apparently such policies have been developed because of the relatively high birth rates of these groups and the localized nature of their problems and the corresponding loss of hope in the possibility of dispersion and absorption in the general population.

In a democracy the choice as to its future course must be left mainly up to the individual minority. Should the Wesorts desire to organize into a corporation or association for mutual aid, such a course is perfectly within their rights. If, on the other hand, they should desire to continue, as they have for decades, to raise themselves socially as individuals and families only, this too could only meet with the cooperation and good wishes of their fellow citizens, both White and Negro. It will be of interest to watch the effects of future contacts of the Wesorts with similar mixed groups in the eastern States.

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ZOOLOGY.—*The subspecies and intergrades of the Florida burrowing crayfish,* Procambarus rogersi (*Hobbs*).[1] Horton H. Hobbs, Jr., University of Florida. (Communicated by Waldo L. Schmitt.)

The first record of the presence of burrowing crayfishes occurring in the State of Florida that has come to my attention was that of Roland M. Harper (1914, p. 248). In discussing the Apalachicola flatwoods he states, "Much of the soil is too damp for ants, gophers, and salamanders, but crawfish are common in some places, if one may judge from their 'chimneys,' which are usually closed at the top, instead of open like the more familiar ones in more clayey soils farther inland." These burrows were probably constructed by one or more of the following crayfishes: *P. rogersi campestris, P. rogersi ochlocknensis, P. rogersi* intergrades, *P. kilbyi,*[2] *P. apalachicolae,*[3] and *P. latipleurum,*[4] all of which have been found in portions of the Apalachicola flatwoods.

The subspecies of *Procambarus rogersi*—*P. r. rogersi*, *P. r. campestris*, and *P. r. ochlocknensis*—are characterized by the structure of the first pleopod of the first form male. The mesial process is well developed, spiniform, or slightly compressed; the cephalic process is either lacking or is present as a reduced spine on the cephalodistal surface; the caudal process is large and thumblike, bent mesiad at a 15°–90° angle with the main shaft; the central projection is large and platelike, directed across the cephalodistal surface or obliquely distad in a cephalomesial to caudolateral direction. Hooks are present on the ischiopodites of only the third pereiopods of the male.

The subspecies are distinct, though forming at times unmistakable intergrades. Their ranges cover a considerable area in the eastern and central parts of the panhandle of Florida. The extreme eastern and western limits of the ranges of this assemblage are almost 100 miles apart, while the most northern and southern limits are separated by a distance of about 50 miles. Within these limits are portions of Bay, Gadsden, Gulf, Calhoun, Franklin, Leon, Liberty, and Wakulla Counties.

All three are primary burrowers,[5] with presumably poor powers of dispersal. Their ranges extend through a monotonous flatwoods, broken only here and there by small, scattered areas unsuitable for habitation by them. If *rogersi* had a higher vagility, such a range would seem to favor maintenance of a homogeneous population over the entire area, but instead the region is inhabited by small, local, inbred populations. When specimens from several of these are compared, it becomes evident that the subspecies of *P. rogersi* and their intergrades form a very heterogeneous complex.

The zone of intergradation consists of a large area in Franklin, Gulf, and Bay Counties and the southern parts of Liberty and Wakulla Counties. Toward the eastern side of this area, in eastern Franklin and western Wakulla Counties, specimens show a definite approach to *rogersi campestris,* which occurs in Leon and Wakulla Counties; west of the Apalachicola River, in northern Gulf County, material is closer to *rogersi rogersi;* while in the southern part of Liberty County the intermediates in most characters more closely resemble *rogersi ochlocknensis.* In general, the nearer one approaches the ranges of each of the three well-defined subspecies, the more nearly do the intermediates resemble typical material of the subspecies from that particular part of the range. The actual situation in respect to the intergrades is more complex than is here indicated and will be discussed more in detail following the descriptions of the subspecies.

SYSTEMATIC DISCUSSION

KEYS TO THE SUBSPECIES OF PROCAMBARUS ROGERSI[6]

Males

1. Caudal process of first pleopod bent but not so much as at a right angle to the main shaft of the appendage....................2

[1] Contribution from Department of Biology, University of Florida. Received February 27, 1945.
[2] Hobbs, 1940, p. 410.
[3] Hobbs, 1942b, p. 55. [4] Hobbs, 1942b, p. 52.

[5] Primary burrowers are those crayfish that spend practically their entire lives in their burrows.
[6] It is not possible to construct a key to the intergrades of the several subspecies of *P. rogersi.* These are fully discussed on page 257.

Caudal process of first pleopod bent at a right angle to the main shaft of the appendage. . . . . *rogersi rogersi*

2. Central projection of first pleopod directed laterad across the cephalic face of the appendage . . . . *rogersi campestris*
   Central projection of first pleopod directed obliquely caudolaterad from the cephalo-distal surface . . . . *rogersi ochlocknensis*

Females

1. Annulus ventralis only slightly if at all broader than long, usually longer than broad; cephalic margin cleft, with strongly developed tubercles 2
   Annulus ventralis much broader than long; cephalic margin entire, with or without very low, rounded tubercles . . . . . . *rogersi rogersi*
2. Annulus ventralis subcylindrical; caudal half not anywhere flattened; cephalic half troughlike . . . . *rogersi campestris*
   Annulus ventralis much longer than broad; caudal half flattened below with a single large, median, dome-shaped structure; cephalic half vatlike . . . . . *rogersi ochlocknensis*

Procambarus rogersi rogersi (Hobbs)

Figs. 2, 14, 17, 22, 25

Cambarus rogersi Hobbs, 1938, pp. 61–65, figs. 1–11; 1940, p. 410.
Procambarus rogersi Hobbs, 1942a, p. 344.
Procambarus rogersi rogersi Hobbs, 1942b, p. 89, pl. 5, figs. 71–75, map 5.

Diagnosis.—Hooks present on ischiopodites of third pereiopods only; rostrum without lateral spines, areola obliterated in middle, or almost obliterated with a single row of punctations along fusion line of branchiostegites. First pleopod of first form male with platelike central projection directed across cephalic surface, caudal process noncorneous, thumblike, and bent caudomesiad at a right angle to the main shaft. Annulus ventralis broader than long; cephalic margin entire.

Description.—Paratypic male, form I: Carapace subovate. Width of carapace in region of caudodorsal margin of cervical groove greater than height (1.32–1.27 cm). Greatest width of carapace about midway between cervical groove and caudal margin of cephalothorax (1.45 cm).

Areola obliterated in middle, depressed, more than half as long as cephalic section of carapace (1.17–1.69 cm).

Rostrum broad-lanceolate; apex not reaching distal end of second joint of antennule peduncle; upper surface excavate, with a row of punctations along raised margins; margins gradually tapering to apex; no lateral spines present. Apex of rostrum directed ventrad, extreme apex abruptly bent upward. Subrostral ridges evident in dorsal view for over half the distance between postorbital ridges and tip of rostrum. Rostral ridges extending forward to apex of rostrum. Postorbital ridges extending caudad more than half the distance between apex of rostrum and cervical groove.

Surface of carapace punctate dorsad; granulate laterad. No lateral spines present. Suborbital angle lacking. Branchiostegal spines small.

Abdomen shorter and narrower than carapace. Anterior section of telson with one spine in the right and two in the left posterolateral angles.

Epistome broadly sublanceolate with slightly undulant margins; terminating cephalad in a small cephalomedian tubercle.

Antennules of the usual form; no spines present on ventral side of basal segment.

Antennae hardly reaching caudal margin of carapace when bent caudad. Antennal scale small; extending almost to end of second joint of peduncle of antennule. Spine on outer margin strong.

First pereiopod very broad and flattened, triangulate, with sharp apex. Inner margin of palm with a cristiform row of eight tubercles. Both surfaces of hand as well as fingers with setiferous punctations. Both fingers with two distinct ridges. Palm with a prominent ridge along articulation with movable finger. *Movable finger:* Dorsal surface with a prominent submedian ridge extending from base almost to tip. Outer margin studded with four tubercles along proximal third; remaining distal two-thirds with about eight setiferous punctations. Opposable margin with excision slightly proximad of midlength; margin broken by two major tubercles (one at point of excision, the other near base of finger) between which are two smaller ones; four small tubercles present distad of distal major tubercle beyond which is a row of minute denticles extending almost to tip of finger. *Immovable finger:* Outer margin, in the form of a distinct ridge, with deep setiferous punctations; a few small tubercles present at base. Dorsal surface of finger with a prominent submedian ridge which curves inward at base following the general curvature of opposable margin of finger. Opposable margin interrupted by five tubercles, the second from base the largest. *Carpus* longer than broad; longer

than inner margin of palm of chela; a deep longitudinal groove above; inner surface with three large tubercles and a few scattered smaller ones. Two large, acute tubercles on distal ventromesial surface. A single large, ball-like tubercle on distal ventrolateral margin fits into a socket on lower surface of chela. *Merus* smooth except on lower surface which has an inner row of ten small, spikelike tubercles and an outer row of nine rounded ones.

Ischiopodite of third pereiopod hooked; hook strong, long.

First pleopod of male extending cephalad to base of second pereiopod. Tip terminating in three distinct parts. The mesial process, heavy but terminating in a spiniform tip, is bent caudolaterad. The cephalic process is absent. The caudal process is noncorneous, thumblike, and directed caudomesiad at a right angle to the main shaft of the appendage. The central projection is thin, corneous, and platelike and is directed across the cephalic surface of the appendage.

PARATYPIC MALE, FORM II: Differs from the male of the first form chiefly in the reduction of the sexual and secondary sexual characters, a total absence of corneous parts in the first pleopod, and a reduction of the hooks on the third pereiopods.

PARATYPIC FEMALE: Differs from the male of the first form in that the chelae are not so heavy, and there are slight variations in position and size of tubercles.

Annulus ventralis broader than long with fossa disappearing below left caudal margin. Cephalic margin entire with only very low rounded tubercles. A deep pit present in dextral half with rather steep walls except on cephalic and sinistral sides; caudal wall definitely overhanging. Sinus cutting caudal wall slightly sinistrad of midlength.

Measurements.—PARATYPIC MALE: Carapace, height 1.32, width 1.45, length 2.86 cm; areola, linear, length 1.17 cm; rostrum, length 0.28, width 0.35 cm; abdomen, length 2.40 cm; right chela, length of inner margin of palm 0.66, width of palm 1.11, length of outer margin of hand 1.92, length of movable finger 1.36 cm. PARATYPIC FEMALE: Carapace, height 1.20, width 1.27, length 2.48 cm; areola linear, length 0.96 cm; rostrum, length 0.33, width 0.33 cm; abdomen, length 2.30 cm; right chela, length of inner margin of palm 0.51, width of palm 0.88, length of outer margin of hand 1.57, length of movable finger 1.07 cm.

Type locality.—"Low pine flat-woods four miles north of Blountstown on State Highway no. 6" (Hobbs, 1938, p. 65).

Distribution.—Calhoun County, Fla.

Procambarus rogersi rogersi is endemic to Florida, and its range seems to be confined to a relatively small area in the panhandle of the State west of the Apalachicola River. Here it occupies a small area of flatwoods running north and south in the eastern part of Calhoun (and probably Gulf) County. Although no records of *rogersi rogersi* have been established in Gulf County, there are records of what I interpret as intergrades, *P. r. rogersi* ×*campestris*, in the broad expanse of coastal flatwoods in the southern part of the county.

The linear form of the range of this subspecies may be explained by the distribution of the available flatwoods and the presence of the Apalachicola River on the east and the elevated strip of loamy Norfolk sand that extends on the east side of the River from Liberty County to the northern part of Franklin County. The combination of the two latter features certainly prevents migration eastward. The northern and western boundaries of the range are determined by well-drained soils that appear to form an efficient barrier to migration. The western boundary extends as far southward as the central part of Gulf County, but the southern limit of the range cannot be definitely set since the intergradation zone (*rogersi* ×*campestris* ×*ochlocknensis*) probably occurs in Gulf County.

Variation.—*Procambarus rogersi rogersi* seems to show little variation. In most of the specimens there is no spine present on the ventral surface of the basal joint of the antennule; however, occasionally there is a spine on one or both antennules. The cephalic process of the first pleopod of the male is generally not even present as a vestige, though occasionally it is strongly developed. The areola is sometimes not quite obliterated in middle. The epistome varies in form from semicircular to subtriangular.

Ecology.—*Procambarus rogersi rogersi* is a primary burrowing species and has been collected only in the flatwoods region around Blountstown. A definite plant association composed of pitcherplants (*Sarracenia drummondi*,

S. flava, and *S. psittacina*), sundews (*Drosera*), club moss (*Lycopodium*), wiregrass, and hatpins (*Ericaulon*) is characteristic of the flatwoods flora where this crayfish has been taken. Generally in a locality in which these plants were observed from the road, burrows of some member of the *rogersi* group were found to be present; only in a few instances have I found no crayfish burrows in a situation of this type. In many places the water table is only a few inches below the surface, in others as deep as 3 feet.

The crayfish burrows are numerous in the Blountstown region, and since the chimneys range from 4 to 8 inches in height they are easily observed. The soil is a mixture of sand and clay underlain by clay, and the pellets composing the chimneys retain their rounded shape. Most of the chimneys are somewhat carefully constructed.

P. rogersi constructs a very complex burrow, which often extends horizontally 4 or 5 feet. Usually there are several passages—some that end blindly and others that open to the outside through chimneys. Generally, as in the case of the *advena*[7] burrows, there is a single spiral passage that goes below the average water table. In some places the water is reached in less than a foot; in others it is about 2 feet below the surface. In any case, I have never had to dig more than 3 feet to reach the bottom of the passage.

In digging out a specimen from its burrow it is best to locate the deep passage and stir the water in it vigorously; allow it to become still, and within a very short time the crayfish will usually come to the surface. Occasionally it is necessary to dig to the bottom, or in some instances to dig out the entire burrow. Although most of my specimens have been taken from the deepest passage of the burrow I have found some clinging to the roots of wiregrass or of some other plant in the roof of one of the horizontal passages.

[7] LeConte, 1856, p. 402.

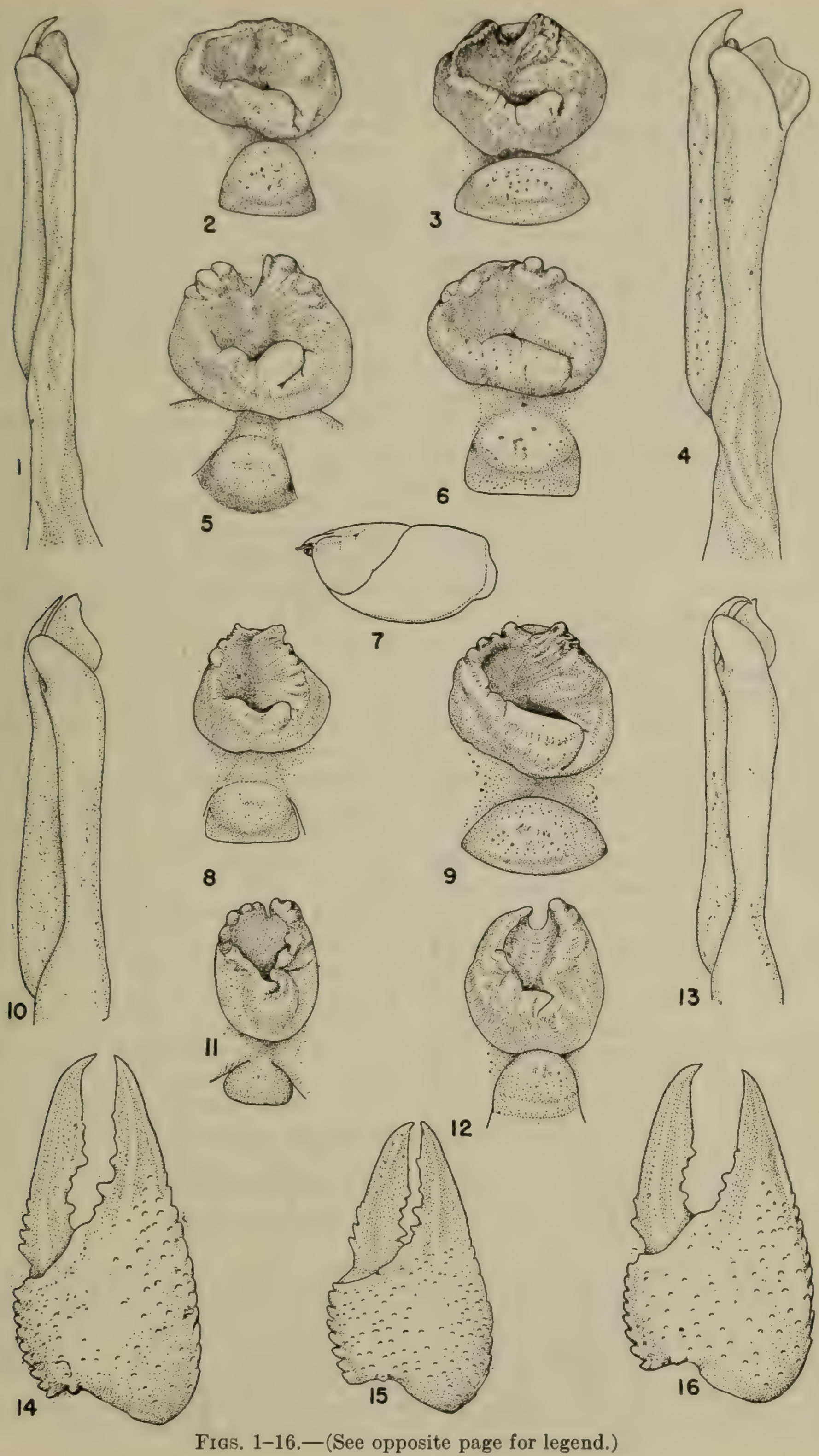
In one locality (about 8 miles north of Blountstown) the open, gently sloping flatwoods are essentially a large seepage area covering several acres. The ground is very spongy, and in spots, were it not for the heavy growth of grass, one would probably "bog down." In this locality the burrows are extremely numerous. As the water table is probably at the surface most of the year, the crayfish in their burrowing seem to expend their energy in constructing horizontal passages. In this locality the ground is so riddled with burrows that one can scarcely dig a spadeful of soil without exposing one of them.

In the burrows just mentioned an amphipod (*Crangonyx* sp.), an albinistic isopod (*Asellus hobbsi* Maloney), a beetle (*Bidessus rogersi* Young), and a copepod (*Cyclops* sp.) are abundant. On the crayfish were found some of the amphipods mentioned above, a branchiobdellid [*Cambarincola philadelphica* (Leidy)], and an ostracod.

Although I have taken no other crayfish from burrows in the same habitat with *rogersi rogersi*, *P. kilbyi* was collected in large numbers from burrows and among the vegetation in a temporary stream close by.

Material examined.—CALHOUN COUNTY: 4 miles north of Blountstown [State Highway 6] (4-1335-1, 1 ♂I, 3 ♀ ♀), (4-1737-4, 2 ♂ ♂I, 2 ♂ ♂II, 1 ♀); 8 miles north of Blountstown [State Highway 6] (4-1737-2, 5 ♂ ♂I, 2 ♂ ♂II, 3 ♀ ♀), (6-938-4, 2 ♂ ♂II, 9 ♀ ♀); 9 miles north of Blountstown [State Highway 6] (4-738-11

FIGS. 1–16.—1, Caudal view of first pleopod of male, form II, *Procambarus rogersi ochlocknensis;* 2, annulus ventralis of *P. r. rogersi* from Calhoun County; 3, annulus ventralis of *P. r. campestris* from Leon County; 4, caudal view of first pleopod of male, form II, *P. r. campestris;* 5, annulus ventralis of an intergrade from Franklin County, west of the Apalachicola River; 6, annulus ventralis of an integrade from Franklin County, near the Franklin-Wakulla County line; 7, lateral view of carapace of *P. r. campestris;* 8, annulus ventralis of an intergrade from Franklin County 10 miles west of Carrabelle; 9, annulus ventralis of an intergrade from Franklin County 7 miles west of Carrabelle; 10, caudal view of first pleopod of male, form I, *P. r. ochlocknensis* from Liberty County; 11, annulus ventralis of *P. r. ochlocknensis* from Gadsden County; 12, annulus ventralis of *P. r. ochlocknensis* from Liberty County; 13, Caudal view of first pleopod of male, form I, *P. r. ochlocknensis* from Gadsden County; 14, upper surface of chela of *P. r. rogersi* from Calhoun County; 15, upper surface of chela of *P. r. ochlocknensis* from Liberty County; 16, upper surface of chela of *P. r. campestris* from Leon County. The drawings of the chelae (Figs. 14–16) were made from paratypes, and so there are some discrepancies in the illustrations and text in the number and distribution of tubercles. Pubescence has been removed from all structures figured.



Figs. 1–16.—(See opposite page for legend.)

2 ♂♂I, 1 ♀); 2.5 miles south of Blountstown [State Highway 6] (4-738-9, 1 ♂I); 5.5 miles south of Blountstown [State Highway 6] (5-341-16, 1 ♂I, 1 ♀).

Procambarus rogersi ochlocknensis Hobbs
Figs. 1, 10, 11, 13, 15, 19, 20, 26

Procambarus rogersi ochlocknensis Hobbs, 1942b, p. 89, pl. 5, figs. 76–80, map 5.

Diagnosis.—Hooks present on ischiopodites of third pereiopods only; rostrum without lateral spines; areola obliterated in middle. First pleopod of first form male with fanlike central projection directed caudolaterad; caudal process noncorneous (somewhat swollen but not distinctly thumblike as in the other subspecies of *rogersi*) and directed at a 15°–40° angle to the main shaft. Annulus ventralis ovate with the greatest length in the longitudinal axis, the cephalic border deeply cleft.

Description.—Holotypic male, form I: Differs from *P. rogersi rogersi* in the following points: Ratio of height to width of carapace in region of caudodorsal margin of cervical groove 1.25:1.23. Areola 42.3 per cent of entire length of carapace; obliterated. Rostrum with margins slightly concave, deeply excavate above. Subrostral ridges evident in dorsal aspect to base of acumen. Lateral surface of carapace entirely granulate. Branchiostegal spines absent. Anterior section of telson with two spines in each of the posterolateral angles. Epistome subtriangular with a single gentle swelling on each cephalolateral margin. Inner margin of palm of first right pereiopod with a cristiform row of nine tubercles. Chela slightly narrower than in other two races (i.e., proportion of width of hand to length of inner margin of palm). (See Fig. 15.) Opposable margin of movable finger without deep excision in basal half; outer margin with two tubercles along proximal two-fifths. Opposable margin of immovable finger with five tubercles ranging in size (numbering from base) from the largest 3, 5, 2, 4, 1; minute denticles crowded along distal half of same margin interrupted by the two more distal tubercles. Carpus with only two spines on distal portion of inner surface.

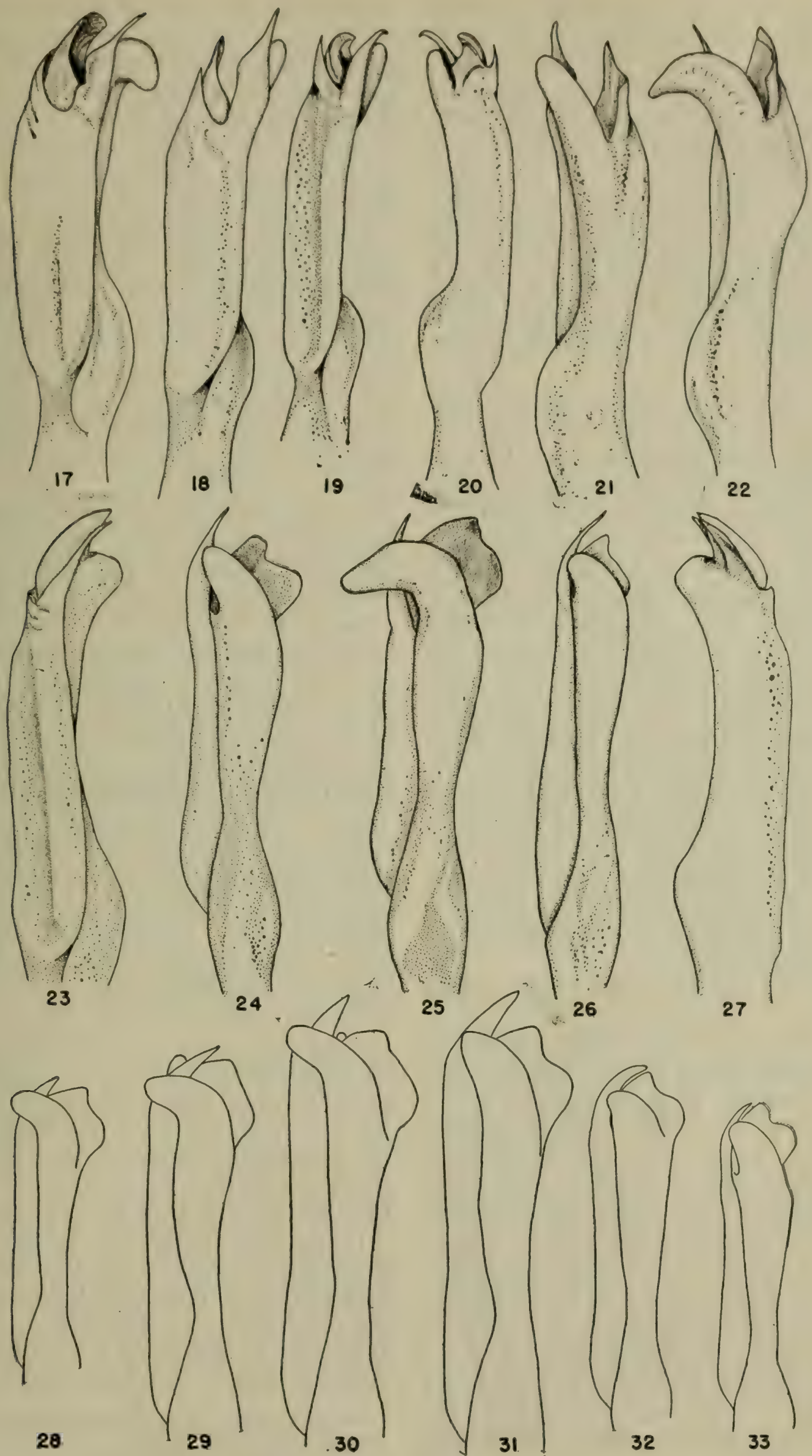
First pleopod extending almost to base of second pereiopod; tip ending in four distinct parts. The mesial process, long and spiniform, is bent caudad and laterad. The cephalic process is a small spiculiform spine partially hidden, particularly in caudal view, by the central projection. It is hidden among the subterminal plumose setae. The caudal process is heavy, noncorneous, somewhat inflated, and is directed mesiodistad. The central projection is a corneous, thin, platelike structure directed obliquely caudolaterad from the cephalodistal surface.

Paratypic male, form II: Differs from the first form male in the usual reduction of spiny and corneous parts. Epistome more elongate than in the first form male. Right rostral ridge not continuous to tip but similar to that of the holotype of *rogersi campestris*.

Allotypic female: Differs only in a few minor points from the first form male. Spiny portions reduced. The number of tubercles on the inner margin of the chelae is nine and seven, left and right, respectively. The rostrum is similar to that of the second form male; margins not as decidedly concave.

Annulus ventralis differing from that of *rogersi rogersi* in the following points: Cephalic wall deeply cleft; opening ditchlike with high lateral walls (in some specimens walls overhanging). Lateral walls with a few large rounded tubercles. These walls are directed caudolaterad, and just cephalad of midlength are suddenly bent mesiad and diminish in height to the level of the caudal part of the organ. Across the caudal face of the fossa the wall is somewhat pinched so that it is slightly contorted and folded. In the sinistral caudolateral portion there is an oval mound cut by the caudal portion of the sinus. The general outline is subovate with the greatest length in the longitudinal rather than in the transverse axis as in *rogersi rogersi*.

Figs. 17–33.—17, Mesial view of first pleopod of male, form I, *Procambarus rogersi rogersi;* 18, mesial view of first pleopod of male, form I, *P. r. campestris;* 19, mesial view of first pleopod of male, form I, *P. r. ochlocknensis;* 20, lateral view of first pleopod of male, form I, *P. r. ochlocknensis;* 21, lateral view of first pleopod of male, form I, *P. r. campestris;* 22, lateral view of first pleopod of male, form I, *P. r. rogersi;* 23, mesial view of first pleopod of male, form I, *P. advena;* 24, caudal view of first pleopod of male, form I, *P. r. campestris;* 25, caudal view of first pleopod of male, form I, *P. r. rogersi;* 26, caudal view of first pleopod of male, form I, *P. r. ochlocknensis;* 27, lateral view of first pleopod of male, form I, *Procambarus advena;* 28–33, caudal views of the first pleopods of males from the region of intergradation (28, Bay County; 29, Gulf County; 30–32, Franklin County; 33, Wakulla County). Pubescence has been removed from all structures figured.



Figs. 17–33.—(See opposite page for legend.)

Measurements.—HOLOTYPE: Carapace, height 1.25, width 1.23, length 2.65 cm; areola linear, length 1.12 cm; rostrum, length 0.30, width 0.35 cm; abdomen, length 2.37 cm; right chela, inner margin of palm 0.55, width of palm 0.88, length of outer margin of hand 1.56, length of movable finger 1.05 cm.

ALLOTYPE: Carapace, height 1.16, width 1.27, length 2.51 cm; areola linear, length 0.96 cm, rostrum, length 0.30, width 0.35 cm; abdomen, length 2.31 cm; left chela, inner margin of palm 0.57, width of palm 0.95, length of outer margin of hand 1.50, length of movable finger 1.00 cm.

Type locality.—Seven and three-tenths miles west of Quincy on U. S. Highway 90, Gadsden County, Fla. In this locality a narrow strip of grassy flatwoods borders a swampy area along Telogia Creek, a tributary to the Ochlocknee River. *Pinus palustris*, two Sarracenias (perhaps *psittacina* and *flava*), and grasses make up the more conspicuous vegetation of the area, while *Pogonia*, *Aletris*, *Ascyrum*, and *Hypericum* are common. Along the swamp margin are *Cerothamnus*, *Magnolia virginiana*, *Hydrangea*, and an evergreen shrub, possibly *Nyssa biflora*.

Disposition of types.—The holotypic male, the allotypic female, and a paratypic male, form II, are deposited in the United States National Museum (no. 79383). Of the remaining paratypes, one male, form I, one male, form II, and a female are deposited in the Museum of Comparative Zoology; one male, form I, five males, form II, and six females are in my personal collection.

Distribution.—Gadsden and Liberty Counties, Fla.

This subspecies is probably confined to Gadsden and northern Liberty Counties and is perhaps restricted to areas adjacent to the Telogia River, a tributary of the Ochlocknee River. Thus to the north this subspecies is limited in its range by well-drained areas bordering Telogia Creek, which extends a little north of U. S. Highway 90 between Quincy and River Junction. The eastern boundary seems to be clearly marked by the Ochlocknee River, while the western limit is terminated by a strip of high, well-drained soils east of the Apalachicola River in Liberty County. At the south there is no sharp demarcation line between this subspecies, *rogersi rogersi* and *rogersi campestris*.

Variation.—Few variations have been observed among the specimens examined. The annulus ventralis and the first pleopod of the male show a few slight differences, and the number of tubercles along the inner margin of the palm of the chela is variable. Other slight variations occur in the rostrum, epistome, and in various spiny portions.

Ecology.—*P. rogersi ochlocknensis* has been taken from two types of situations. The localities in Gadsden County are fluctuating seepage areas along a small stream and in narrow strips of flatwoods bordering streams. The burrows here are typical of the *rogersi* group, and the soil from which they were dug is a coarse sandy clay in some places overlain by muck or sandy loam; the water table ranges from the surface to about two feet below it.

In Liberty County most of the specimens were taken from burrows in the flatwoods. Here for the most part the soil is a sandy mixture, and in places clay is almost at the surface. The water table is 6 to 18 inches below the surface. The burrows are 1 to 2 feet deep and extremely rambling, many with several carefully built chimneys, which are of the same type described for *P. rogersi rogersi*. The plant associations in this locality are dominated by pines, ti-ti (*Cliftonia monophylla*), and *Ascyrum linifolium; Drosera* and other semiaquatics are common. In another area of gently sloping pine flatwoods, the commoner plants consist of *Pinus* sp., *Cliftonia monophylla*, *Ilex glaber*, *Pinguicula* sp., *Aronia arbutifolia*, *Cyanococcus* spp., *Drosera* sp., and wiregrass. The soil is probably of the Plummer series. The crayfish were taken from complex burrows averaging 1 to $1\frac{1}{2}$ feet in depth. *Procambarus kilbyi* was taken from adjacent burrows that are much simpler in structure. Ostracods and branchiobdellids (*Cambarincola* sp.) were found clinging to *rogersi ochlocknensis*. In general the habits of this crayfish seem to be similar to those of *P. rogersi rogersi*.

In the type locality in Gadsden County *Procambarus leonensis*[8] was taken from burrows adjacent to those of *ochlocknensis*, and in the stream close by this same species was, along with *P. spiculifer*,[9] and *Orconectes clypeata*.[10] In Liberty County *P. kilbyi* was taken

[8] Hobbs, 1942b, p. 114; 1942c, p. 49.
[9] LeConte, 1856, p. 401.
[10] Hay, 1899, pp. 122–123.

from burrows interspaced among the burrows of *ochlocknensis*.

Material examined.—GADSDEN COUNTY: 7.3 miles west of Quincy [U. S. Highway 90] (4-1437-1, 1 ♂I, 1 ♀), (3-1739-3, 1 ♀), (5-141-1a, 2 ♂♂I, 2 ♂♂II, 2 ♀♀); 8.3 miles southwest of junction of State Highways 12 and 135 on Highway 135 (5-141-3, 1 ♂I, 1 ♀); 2.7 miles southwest of junction of U. S. Highway 90 and State Highway 12 on Highway 12 (5-141-2, 1 ♂II). LIBERTY COUNTY: 4.5 miles north of Hosford [State Highway 135] (5-141-5, 3 ♂♂II, 3 ♀♀). The remaining specimens from following localities are slightly atypical: Near Hosford (12-937-1a, 1 ♂I); 1.6 miles west of the Ochlocknee River [State Highway 19] (3-1639-1a, 1 ♂I, 1 ♂II, 8 ♀♀); 4 miles east of Hosford [State Highway 19] (3-1739-1a, 2 ♂♂I, 2 ♂♂II, 7 ♀♀, 2 ♀♀ with eggs, 1 ♂ imm., 1 ♀ imm.); 9 miles west of Hosford [State Highway 19] (3-1739-8a, 1 ♀); near Hosford (8-234-1, 1 ♀); 3.5 miles east of Hosford [State Highway 19] (4-841-1, 2♂♂II, 1 ♀ with eggs).

Procambarus rogersi campestris Hobbs

Figs. 3, 4, 7, 16, 18, 21, 24

Procambarus rogersi campestris Hobbs, 1942b, p. 90, pl. 6, figs. 81–85, map 5.

Diagnosis.—Hooks present on ischiopodites of third pereiopods only; rostrum without lateral spines; areola obliterated in middle. First pleopod of first form male with fanlike central projection directed across cephalic surface; caudal process thumblike and directed at a 45° angle to the main shaft. Annulus ventralis subcylindrical with cephalic border open; troughlike with high, multituberculate lateral ridges.

Description.—HOLOTYPIC MALE, FORM I: Differing from one or the other subspecies in the following points: Width of carapace greater than height (1.65:1.45 cm). Areola 40.9 per cent of entire length of carapace. Areola obliterated; no punctations in fusion line of branchiostegites. Subrostral ridges prominent; rostral ridges do not extend to tip of rostrum. (See Fig. 7.) Cephalic region in lateral aspect not evenly rounded. Lateral surfaces of carapace granulate. Branchiostegal spines absent. Anterior section of telson with two spines in each of the posterolateral angles. Epistome broadly subovate with an acute cephalomedian projection. Antennules with a spine present on ventral side of basal segments. Inner margin of palm of first pereiopod with a cristiform row of nine tubercles. Opposable margin of movable finger with deep excision in basal half. Outer margin with five tubercles on proximal half. Outer margin of immovable finger bearing a row of tubercles along proximal half and setiferous punctations on distal half. The one major tubercle on opposable margin lies somewhat distad of midway between the two major tubercles on movable finger. Two smaller tubercles proximad of the major tubercle. A single row of minute denticles along distal half is broken at intervals by five tubercles.

First pleopod extending to base of second pereiopod, distinctly separated at tip; tip ending in four parts. The mesial process is heavy and sinuate (in mesial view), tapering to a point; bent obliquely and laterally, passing beneath the caudal process. The cephalic process is much reduced (can be seen only in mesial and cephalic views), and is closely applied to the central projection at the base of the cephalomesial face. The caudal process is large and thumblike and extends at a 45° angle to the main shaft in a mesiodistal direction. The central projection forms a large corneous fan across the cephalic side of the tip and is also bent at about a 45° angle to the main shaft; however, directed laterodistad.

PARATYPIC MALE, FORM II: Differs from the first form male in only a few minor details, chiefly in the reduction of the sexual and secondary sexual parts (there being no corneous parts), and the number of tubercles and spines. The cephalic process of the first pleopod is much more conspicuous in the second form male than in the male of the first form. The rostral ridges extend to the tip of the acumen. Anterior section of telson with one spine in each posterolateral angle.

ALLOTYPIC FEMALE: Besides the sexual and secondary sexual characters, the female differs from the first form male in the following points: Spiny and tuberculate portions slightly different; right rostral ridge as in holotype; left as in second form male paratype.

Annulus ventralis differing from that of *rogersi rogersi* in the following points: Cephalic wall open, troughlike, with rather high lateral walls. Lateral walls tuberculate cephalad, and continuous with the caudal wall which is

lower, decidedly lower left of the midventral line. Whereas the annulus of *rogersi rogersi* is subovate and broader than long, the annulus of *rogersi campestris* is subcylindrical.

Measurements.—HOLOTYPE: Carapace, height 1.45, width 1.65, length 3.15 cm; areola linear, length 1.29 cm; rostrum, length 0.40, width 0.39 cm; abdomen, length 2.90 cm; right chela, inner margin of palm 0.74, width of palm 1.28, length of outer margin of hand 2.19, length of movable finger 1.46 cm. ALLOTYPE: Carapace, height 1.35, width 1.54, length 3.02 cm; areola, linear, length 1.15 cm; rostrum, length 0.36, width 0.39 cm; abdomen, length 2.90 cm; right chela, inner margin of palm 0.65, width of palm 1.12, length of outer margin of hand 1.97, length of movable finger 1.34 cm.

Type locality.—A low, pine flatwoods about 12 miles south of Tallahassee, Leon County, Fla., along the east side of Horseshoe Bay (the exact location: Sec. 16–17, T. 25, R. 2 W.). This locality is a typical sour-gum and ti-ti bay region. The hammock is quite low, with very acid soil and water, and is subject to flooding in wet weather. The soil is largely muck and sand, and at the time of digging the water table was about 3 feet below the surface. Pines, wiregrass, palmetto, gallberry, and ti-ti shrubs are characteristic of the flora, and pitcherplants and sundews are common.

Disposition of types.—The holotypic male, form I, the allotypic female, and a form II male paratype are deposited in the United States National Museum (no. 79384). Two female paratypes are in the Museum of Comparative Zoology. The remaining paratypes, one male, form I, one male, form II, and 13 females are in my personal collection.

Distribution.—Leon and Wakulla Counties. The typical forms of *P. rogersi campestris* are found in the southwestern part of Leon and northwestern part of Wakulla Counties. This subspecies is also a Florida endemic and probably occupies the greater portion of the western half of Wakulla and the southwestern quarter of Leon Counties.

The range of *campestris* is bounded on the west by the Ochlocknee River, which, together with the well-drained soils adjacent to it, serves as an effective barrier in Leon and the northern part of Wakulla Counties but is only a partial barrier in the southern part of Wakulla County; the eastern boundary is a region of high, well-drained soils extending through the middle of Wakulla County to the Gulf. The northern boundary lies in the southwestern part of Leon County where the flatwoods end in well-drained, rolling hills.

Variation.—There is no indication of inbred local populations among my specimens of *P. rogersi campestris;* the only differences observed seem to be individual ones, involving sizes and positions of spines and tubercles.

Ecology.—Like the other members of this species, *rogersi campestris* is a primary burrower, apparently confined to flatwoods. The flatwoods east of the Ochlocknee River are not markedly different from those described in the discussion of the ecology of *P. rogersi rogersi*, except that the soil is underlain by hardpan rather than clay. There are pines, wiregrass, pitcherplants, sundews, etc., and the soil is much the same general type—that is, most of it is poorly drained and supports an abundant growth of semiaquatic plants.

The burrows are very complex and often run horizontally for several feet; many of them reach the surface in several places. On one occasion I dug into one of these burrows and followed the spiral passage downward for 5 feet and still had not reached the bottom. This burrow was about a hundred yards from the border of a bayhead, and its unusual depth was probably explained by the fact that just prior to the time I collected here there had been an unusually long dry season.

Several specimens of *Crangonyx* sp. were taken from the burrows, some of them clinging to the abdomens of the crayfish. Many ostracods and branchiobdellid worms (*Cambarincola vitrea* Ellis) were found clinging to the crayfish.

In only two instances has another species been collected with *rogersi campestris. P. kilbyi* was taken from burrows adjacent to those of *campestris.* The burrows of the two species, however, are very distinct in that those of *kilbyi* are generally simple, while those of *campestris* are very complex.

Material examined.—LEON COUNTY: 12 miles southwest of Tallahassee (11-2736-1, 2♂♂I, 2♂♂II, 10♀♀). WAKULLA COUNTY[11]: 28

[11] Perhaps some of the locality records from Wakulla County should be listed under the intergrade localities, although most of the specimens taken here are scarcely to be distinguished from typical *campestris.*

miles north of Sopchoppy [State Highway 127] (6-538-6, 1 ♂I); 2 miles south of Sopchoppy [U. S. Highway 319] (5-2940-8, 1 ♂II, 4 ♀ ♀, 2 ♀ ♀ imm.); 7.5 miles northwest of Sopchoppy [State Highway 127] (6-538-8b, 1 ♀); 7 miles north of Sopchoppy [State Highway 127] (6-538-9, 1 ♂II); 16 miles southwest of Tallahassee (8-0436-2, 6 ♀ ♀).

INTERGRADES

The characters in which the evidences of intergradation are most clearly seen are the structure of the first pleopod of the male and of the annulus ventralis of the female. The variations in these structures are gradual and essentially quantitative rather than discontinuous ones. In the male there is, from one extremity of the range to the other, a gradual change in the degree of bending of certain of the terminal processes and in the relative sizes of the various tips. (See Figs. 1, 4, 10, 13, and 17–33.) For example, the caudal process of the first pleopod of the males from Calhoun County (*rogersi*) is bent laterad at a right angle to the main shaft of the appendage. In specimens from Gulf and Franklin Counties, west of the Apalachicola River (intergrades), the process, while bent, forms less than a right angle with the main shaft. Specimens from Franklin County east of the Apalachicola River and from southern Liberty County (intergrades) have this process even more erect, and finally, in material from Wakulla and Leon Counties (*campestris*), and from northern Liberty and Gadsden Counties (*ochlocknensis*), the process is still more nearly straight. In the region of intergradation occasional specimens occur which are structurally out of place, but considering the series as a whole the gradation is quite evident.

Similarly the annulus ventralis shows gradual changes in gross shape, in configuration of the fossa and sinus, and in surface contour. (See Figs. 2, 3, 5, 6, 8, 9, 11, and 12.) In specimens from Calhoun County (*rogersi*) this structure is subelliptical, with the longest axis directed laterad and with only a few very small tubercles on the cephalic border, which is entire. In specimens from west of the Apalachicola River in Bay and Gulf Counties (intergrades) the annulus is broader than long, but this characteristic is not so marked as in the Calhoun County females; the tubercles on the cephalic border are also more strongly developed. In specimens from east of the Apalachicola in Franklin and Liberty Counties (intergrades) the annulus ventralis is more elongate and the tubercles decidedly higher. The opposite extreme from the annulus ventralis of the Calhoun County specimens is seen in the females from Gadsden County (*ochlocknensis*). Here it is much longer than broad, the cephalic margins strongly tuberculate and cleft. The *campestris* population in Wakulla and Leon Counties has the annulus ventralis more like the Franklin County intergrades.

Additional similarly merging variations may be noted in the figures of these structures. While there are other differences between the three geographic races, they do not show so clearly the gradual blending exhibited by the first pleopod of the male and the annulus ventralis of the female.

As shown by the accompanying map, the area inhabited by the intergrades is larger than the combined ranges of the three defined races, and extends considerably to the west along the coast. That the population of this area does not itself constitute a recognizable race distinct from the others, as might be suspected on geographical grounds, becomes evident when the variation described above is further analyzed. In western Franklin County the crayfish are most nearly intermediate in characteristics between *r. rogersi*, *r. campestris*, and *r. ochlocknensis*, and at the same time are the most heterogeneous, showing the most variable admixtures of the characters of the three races. The farther east one goes in Franklin and southern Wakulla Counties the more nearly does the population approach *campestris*, while in northern Franklin and southern Liberty counties a similar approach occurs to typical *ochlocknensis*. Just west of the Apalachicola River the population is still highly variable, but shows a tendency toward *rogersi*, and probably intergrades fully with that race in the north-central part of Gulf County. Farther west the population is still heterogeneous, though closer to *rogersi* than to either of the more eastern races; however, it can not even be called atypical *rogersi*, since features suggesting *campestris* and *ochlocknensis*, which are never present in typical *rogersi*, occur in individual specimens.

Two rather startling situations involving

specimens from local areas in Bay County deserve further remarks. One of these peculiar situations arises in the peninsula, herein designated as the San Blas Peninsula, between East Bay and the Gulf. The first pleopods of the males taken in this peninsula are almost typical of *rogersi rogersi* from Calhoun County, while the annulus ventralis in the females is not nearly so typical—being similar to that of the intergrades found in other sections of Bay County and in Gulf County. This condition is peculiar, since both males and females from the mainland to the north and east are definitely of the intergrade types. Perhaps an explanation for this apparently local condition may be made by the further assumption that *rogersi rogersi* had already become differentiated by the end of the Pamlico submergence, and as the land emerged to the south, this species followed the retreating shore line, moving out into the area now constituting the San Blas Peninsula. Subsequent influx of the *ochlocknensis* and the *campestris* stocks from the east resulted in the intergradation (hybridization) of these stocks in Gulf and Bay counties, but at the same time establishing two semi-isolated areas of *rogersi rogersi*—one in Calhoun County, the range of typical *rogersi*, and the other in the San Blas Peninsula, the later perhaps being more subject to intergradation than the former because of its geographical and less well isolated position.

The other region that needs further remarks is the one seemingly isolated on the west side of West Bay. I have only three specimens from the West Bay region, a male, form I, taken 1.5 miles north of West Bay, and two females collected about 1 mile south of it. The pleopod of the male very closely approximates that of *rogersi campestris*, but the annuli ventralis, the rostra, and chelae are not typical of any of the subspecies. It has been supposed that there was a continuous area occupied by *rogersi* across the northern shore of both East and West Bay, but recently in attempting to collect this species in this area I drove north along State Highway 52 through the flatwoods section and west from Vicksburg to West Bay on State Highway 83 and was unable to locate a single *rogersi* burrow. This, of course, does not indicate the absence of *rogersi* in the area, but the fact that I did not find it there at least opens the question as to what path of migration the stock took to reach the western shore of West Bay. This might lead one to wonder whether or not the San Blas Peninsula and the adjacent peninsula to the west were at one time connected.

The coastal area of intergradation appears, therefore, to be a zone in which tendencies characteristic of all three races are complexly intermingled. Whether the three named races have arisen through isolation from this stock of intergrades or whether the intergrading coastal population represents later mingling of three stocks that had earlier attained morphological separation is a question. Evidence to be cited below suggests that the latter is the more likely hypothesis.

There is little doubt that the *rogersi* stock was derived from the primitive *advena* stock, and it seems likely that *r. ochlocknensis* is the most primitive form of the complex. The first pleopod as well as the other morphological characters of *r. ochlocknensis* are very similar to those of *P. advena* of southwest-central Georgia. Further evidence to support the supposition that the *rogersi* complex was derived from an ancestral *advena* stock lies in the fact that *advena* occurs in the region of the headwaters of the Ochlocknee, and *r. ochlocknensis* seems to be almost confined to its drainage system in Liberty and Gadsden Counties, Florida. From this stock the two other well-defined races probably arose through isolation, and the variable coastal population of intergrades has probably arisen through later mingling of these once isolated groups. Such a history of isolation followed by remingling may be related to what is known of the geological history of this part of Florida during the Pleistocene.

According to C. Wythe Cooke (1939) in his recent study of the Pleistocene terraces of Florida, Florida was even more emergent during the interval between the Talbot and Pamlico stages than it is today. At this time it would have been possible for the ancestral *ochlocknensis* stock to have entered the present territories occupied by *rogersi* and *campestris* by way of the flat lands bordering the Gulf. This period was followed by the Pamlico submergence, which pushed the coastline well inland, and may well have been the isolating factor responsible for the differentiation of the three races, which were then separated by well-

marked barriers on all sides. The emergence of recent times, with the reestablishment of broad areas of coastal flatwoods suitable for occupancy by the members of the *rogersi* complex, would then account for the remingling of the stocks and the production of the coastal "intergrades" discussed above.

Under present conditions it is evident that the Ochlocknee and Apalachicola Rivers are at least partial barriers to the dispersal of these crayfishes, particularly where there are belts of well-drained soils along their eastern banks. Where such soils intervene there is no evidence of intergradation across these barriers even where the ranges are quite close together. To the south, however, where suitable habitats exist on either side of the rivers, the streams themselves evidently still act as partial barriers, since there is a definite change in the characteristics of the intergrade populations at the rivers.

Material examined.—My evidence of intergradation of the three subspecies of *Procambarus rogersi* is based on approximately 220 specimens collected in Calhoun, Gulf, Bay, Franklin, Wakulla, Gadsden, and Leon Counties, Fla. This listing constitutes a detailed record of the distribution of the intergrades.

BAY COUNTY: 18 miles west of Port St. Joe [U. S. Highway 98] (6-638-8a, 1 ♂II); 17 miles west of Panama City [State Highway 10] (6-638-9b, 1 ♀); 20.6 miles east of Panama City [U. S. Highway 98] (5-3040-7a, 1 ♂II, 2 ♀ ♀); 6.3 miles west of Beacon Hill [U. S. Highway 98] (5-341-2, 2 ♂ ♂I, 2 ♂ ♂II, 1 ♀ with eggs); 12 miles west of Beacon Hill [U. S. Highway 98] (5-341-4a, 1 ♂II); 16.8 miles west of Beacon Hill [U. S. Highway 98] (5-341-5a, 1 ♂I, 1 ♀ with eggs); 5.3 miles southeast of Panama City [U. S. Highway 98] (5-341-6, 4 ♀ ♀, 1 ♀ with eggs); 0.7 miles north of Panama City [State Highway 52] (5-341-7a, 2 ♀ ♀); 2.4 miles north of Panama City [State Highway 52] (5-341-8, 1 ♀, 1 ♀ with eggs); 3 miles east of Panama City [State Highway 52] (5-341-12, 2 ♀ ♀); 7.8 miles east of Panama City [State Highway 52] (5-341-13a, 1 ♀); 13.1 miles east of Panama City [State Highway 52] (5-341-14a, 2 ♂ ♂I, 1 ♂II, 2 ♀ ♀); 1 mile south of West Bay [State Highway 10] (10-1641-6a, 1 ♂I)[12]; 1.5 miles north of West Bay [State Highway 10] (10-1641-7, 1 ♀). FRANKLIN COUNTY: Franklin-Wakulla County line [U. S. Highway 319] (6-538-11, 1 ♂II, 1 ♀); 6.9 miles west of Carrabelle [U. S. Highway 319] (6-638-2a, 2 ♂ ♂II, 3 ♀ ♀, 1 ♀ with young); 9.9 miles west of Carrabelle [U. S. Highway 319] (6-638-3, 1 ♂II, 1 ♀); 3.3 miles west of Apalachicola [U. S. Highway 98] (6-638-4, 1 ♂II, 3 ♀ ♀, 1 ♀ immature); 3.8 miles west of Apalachicola [U. S. Highway 98] (6-638-6, 1 ♂II); 23.3 miles east of Port St. Joe [U. S. Highway 98] (5-3040-4a, 2 ♀ ♀); 5 miles west of Carrabelle [U. S. Highway 319] (5-3040-1, 3 ♂ ♂II, 3 ♀ ♀); 12 miles west of Carrabelle [U. S. Highway 319] (5-3040-2, 2 ♀ ♀); 4.2 miles west of Apalachicola [U. S. Highway 98] (5-3040-3, 1 ♀); 1.9 miles south of Sumatra [State Highway 12] (5-241-8, 3 ♂ ♂I, 2 ♀ ♀); 8.4 miles south of Sumatra [State Highway 12] (5-241-10a, 1 ♀ with eggs); 15.1 miles southeast of Sumatra [State Highway 12] (5-241-11a, 1 ♀); 20.9 miles southeast of Sumatra [State Highway 12] (5-241-12, 1 ♂II); 25.5 miles south of Sumatra [State Highway 12] (5-241-13, 1 ♀); Intersection of State Highway 12 and U. S. Highway 319 (5-241-14a, 3 ♂ ♂I, 1 ♂II, 3 ♀ ♀); 3 miles southwest of intersection of State Highway 12 and U. S. Highway 319 (5-241-15, 1 ♀); 2.3 miles west of Apalachicola [U. S. Highway 98] (5-241-16, 1 ♂I, 2 ♂ ♂II, 1 ♀); 6.9 miles west of Apalachicola [U. S. Highway 98] (5-241-17a, 2 ♂ ♂II); 11.5 miles west of Apalachicola [U. S. Highway 98] (5-241-18, 1 ♂imm., 1 ♀ with eggs). GULF COUNTY: 5.6 miles north of Port St. Joe [State Highway 6] (4-738-4, 1 ♂II, 1 ♀); 0.5 mile west of Wewahitchka [State Highway 52] (5-341-15, 1 ♂I); 17.6 miles west of Apalachicola [U. S. Highway 98] (5-241-19, 1 ♂II, 1 ♀). LIBERTY COUNTY: Vilas (9-1835-1, 1 ♂II, 2 ♀ ♀); 2.6 miles south of Hosford [State Highway 135] (5-141-6, 2 ♂ ♂II, 1 ♀); 4.8 miles south of Telogia [State Highway 135] (5-241-1a, 1 ♂I, 1 ♂II, 1 ♀); 12 miles south of Telogia [State Highway 135] (5-241-4, 2 ♂ ♂II, 1 ♀); 2.6 miles southeast of Wilma [State Highway 135] (5-241-5a, 1 ♂II, 2 ♀ ♀); 6.9 miles southeast of Wilma [State Highway 135] (5-241-6a, 1 ♂I, 1 ♂II); 12.1 miles south of Wilma [State Highway 135] (5-241-7a 2 ♀ ♀).

[12] This was a second form male when caught on October 16, 1941, and molted to first form on December 20, 1941.

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NOTE

This paper was originally accepted for publication in the Proceedings of the United States National Museum, and it was cited as "in press" in my *Crayfishes of Florida* (Hobbs, 1942). Wartime restrictions, however, so delayed publication by the Museum that the manuscript was withdrawn and submitted to this JOURNAL in order that the full descriptions of the two new subspecies of *Procambarus rogersi* might appear more promptly.

I wish to acknowledge the invaluable aid of the following persons who have contributed to my work on this paper, both through help in procuring specimens and in preparation of the manuscript and figures: Dr. Waldo L. Schmitt, Profs. J. S. Rogers and T. H. Hubbell, Drs. Lewis Berner, F. N. Young, and A. M. Laessle, and Messrs. Lewis Marchand and W. L. Brudon. Dr. C. J. Goodnight kindly identified the branchiobdellids for me.

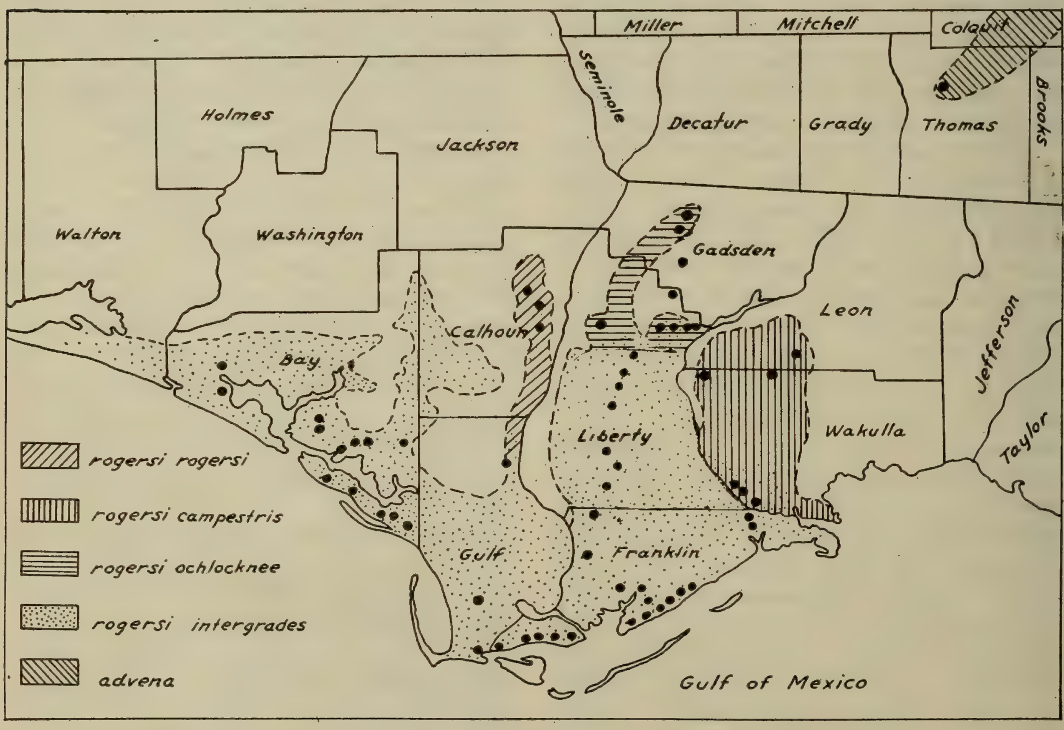

FIG. 34.—Distribution of *Procambarus rogersi* in Florida. The shaded areas indicate the extent of coastal flatwoods or low areas along streams, which seem to be available to the *rogersi* stock. The two localities lying outside of these areas in Gadsden and Liberty Counties are situated along streams that drain into the Telogia River system, thence into the Ochlocknee. The black spots represent the localities at which specimens were collected.

ZOOLOGY.—*Two new leeches (Hirudinea) in the collection of the United States National Museum.*[1] J. Percy Moore, University of Pennsylvania. (Communicated by Waldo L. Schmitt.)

The two leeches herein described are among lots submitted through the interest and kindness of Dr. Waldo L. Schmitt from the collections of the U. S. National Museum. The first, from Mexico, is of exceptional interest. The other species occurs in China and Burma.

Genus **Diestecostoma** Vaillant

Diestecostoma magna, n. sp.

Figs. 1–3

Material examined.—Type, U.S.N.M. no. 20642, Río de los Playas, head waters of Tonalá River between Veracruz and Chiapas, March 1–8, 1944, collected by M. W. Stirling; paratype, labeled "Tehuantepec," collected by F. E. Sumichrast.[2]

Diagnosis.—Size large and form robust with external characters of the genus. Eyes probably normally four pairs on somites III to VI (annuli 3, 4–5, 6, and 9). Total number of annuli (not counting prostomium) 200 or 201. Complete somites 12-annulate, all annuli of nearly equal size. I, II, III each 1-annulate, IV and V 2-annulate, VI 3-annulate, VII 4-annulate, VIII 7 or 8-annulate, IX and X 8-annulate, XI and XII 9-annulate, XIII 10- or 9-annulate XIV 11-annulate, XV–XXII 12-annulate, XXIII probably 10-annulate but may be 12-annulate, XXIV–XXVII together of 19 or 17 annuli. Male pore XI *b4/c9* (ann. 42/43 or 43/44), female pore XIII *c9/c10* (ann. 62/63), separated by 20 or 19 annuli. Anus 194/195 followed by 5 or 6 postanal annuli. Nephropores not seen on VIII or IX, 14 pairs on X to XXIII, first four separated by 9 annuli, fourth and fifth by 10, and the next nine by 12 annuli; last pair (seventeenth) united in a median ventral pore behind ann. 195. Color uniform dark slate above, paler below. Black in life (M. W. Stirling).

The three known species of the genus, namely, *D. octannulata*, *D. mexicana*, and *D. magna*, have complete somites respectively of 8, 10, and 12 annuli. Customarily this would promote generic separation, but in this case nothing would be gained thereby.

Description of type.—A stout leech (Fig. 1) of very firm texture and thick, muscular body walls; cylindroid throughout, little depressed but with venter somewhat flattened, tapered at the ends; in general shaped much like an earthworm and evidently adapted for burrowing. Measurements in millimeters: length 103, to male pore 19; widths, buccal ring 3.5, male 8.5, maximum (XIII, XXI) 10.3, anus *ca.* 9; depths at same points, 2.3, 7, 7, *ca* 5; sucker diameter 6.7. Head region small; lip partially retracted into mouth but when drawn out arched and as seen from below rather wedge-shaped; its dorsum distinctly annulated and areolated; constituted of a prostomial apical lobe not separated by a distinct furrow from the first annulus which forms somite I, following which are four annuli constituting somites II, III, and IV. Venter of lip with margins converging into the buccal chamber, divided by a deep median sulcus and three pairs of shallower furrows into eight flat, smooth ridges. Peristomium or buccal ring formed by the union ventrally of the two annuli (6 and 7) of V, deeply crenate on the margin and with slightly extended small lateral lobes which partially embrace the lateral ends of somite IV. Eyes (Fig. 2) small, not forming a regular arch, the four pairs of distinct pigment cups in two groups on somites III and IV (annuli 3 and 4–5), and V (annulus 6) and VI (annulus 9); besides these are two minute pigment spots, one on the right side of II cephalad of the first definitive eye and the other on VI *a2* mediad of the last right eye. Clitellar region somewhat thickened and at the anterior end of XIII forming one of the widest parts of the body, but its limits not defined externally. Male pore a minute opening in the furrow XI *b4/c9*,

[1] Received March 15, 1945.

[2] In his day Dr. Sumichrast was one of the most valued correspondents of the Smithsonian Institution. For many years he occupied himself with a close and critical study of the natural history of Mexico, and he collected there for the Institution from 1868 to 1876, giving special attention to the Isthmus of Tehuantepec, collecting principally in the states of Veracruz, Oaxaca, and Chiapas, as well as Mexico and Puebla. As Dr. Sumichrast's notebooks seem no longer to be available, it is not now possible to say where the paratype was actually collected.

FIG. 1.—*Diestecostoma magna*, n. sp., right lateral aspect of type; ×1½.

that is, between the fifth and sixth annuli of the somite or the total number of annuli 42/43; female pore at XIII *c8/c9* (annuli 62/63) or 20 annuli caudad of the male, a large orifice cutting into *c8*, which is somewhat reduced and at this point coalesced with *c7*. Anus a large opening with furrowed margins far forward (as in the Erpobdellidae) between annuli 194/195 (counted on left side or 192/193 on right) into which it cuts. Postanal annuli 6, making the total 201. Caudal sucker relatively small, directed ventrad, with a broad peduncle as in *Erpobdella;* the dorsum areolated as on the body in five irregular transverse rows; venter slightly cupped, finely granulated, more coarsely toward the periphery where the margin is thick and crenulate, no radiating ridges or furrows. Nephropores, 15 pairs actually seen, the last belonging to somite XXIV carried caudad to the ventral face of the sucker peduncle, where they are united in a large median pore behind annulus 195, the last annulus developed on the venter. Fourteen pairs are conspicuous pores situated on the caudal border in the ventral intermediate line of *b2* or the equivalent *c4* of every somite from X to XXIII inclusive, that is, on annuli numbered 31, 40, 49, 58, 68, 80, 92, 104, 116, 128, 140, 152, 164 (on left, 163 right), 176 (on left, 174 on right). On somite VIII there is no trace of nephropores, and on IX, while there are small notches at the points where they would be expected, no actual pores were detected. Probably they are transferred to the buccal ring as in *D. mexicana* (Baird), but this can be definitely determined only by means of sections. *Annulation* strongly developed, the furrows deep and on complete somites usually alternately deeper so that the annuli appear grouped in couples, presumably each of two tertiary annuli, but there is some irregularity. Each annulus divided on its dorsal half into usually 24 (up to 28) more or less quadrate areas which are prominently convex, resulting in a conspicuously pebbled surface, finely roughened by numerous minute sensory papillae mostly aggregated in a central group which becomes more elevated on annuli toward the caudal end. Areolae often arranged more or less regularly in longitudinal series continuing over several annuli but oftener staggered and interlocking, especially in the median field. Metameric sensillae not distinguished. On the shorter span of ventral half-annuli an equal number of smaller, smoother, flatter areas. With only the eyes on the head and the nephropores in the middle body region to serve as metameric criteria, the following is a tentative determination of the probable composition of the somites: I, which is scarcely separated from the prostomium, II and II each uniannulate; IV incompletely and V fully biannulate, the latter united ventrally to form the buccal ring; VI 3-annulate (8–10) complete both dorsally and ventrally. Four pairs of eyes on III to VI, a minute supplementary eye on the right side of II and one on VI. VII 4-annulate (11–14), *a1* slightly >*a2*=*b5*=*b6*. VIII 7-annulate (15–21) probably *b3*=*b4*=*b5* slightly >*b1*=*b2*=*c11* =*c12*. IX 8-annulate (22–29) *b1* to *b4*>*c9* to *c12*, in four pairs, possible nephropores on *b2*

(23). X 8-annulate (30–37), like IX but with first certain nephropores on *b2* (31). XI 9-annulate (38–46), three larger annuli in middle preceded by two and followed by four small ones, $b2 = b3 = b4 > c1 = c2 = c9$ to *c12;* nephropore *b2* (40), male pore *b4/c9* (42/43). XII 9-annulate (47–55) like XI but no male pore, nephropore *b2* (49). XIII 10-annulate (56–65) like XII except that *b4* is apparently divided into *c7* and *c8* making two slightly larger preceded by two and followed by six smaller annuli; female pore *c8/c9* (62/63), nephropore *b2* (58). XIV doubtfully 11-annulate (66–76) all tertiaries but *b2*, the third annulus; nephropore *b2* (68). XV–XXI (77–160) each 12-annulate with all tertiaries (*c1–c12*) developed and more or less distinctly arranged in pairs, nephropores on the fourth annulus, *c4* (every 12th annulus from 80 to 152). XXII 12-annulate (161–172) similar to foregoing except that owing to split, spiral, and conjoined annuli, especially in the region of *a1*, two large annuli on the right side replace four small ones on the left, resulting in asymmetry and a discrepancy in the count on the two sides for the remainder of the length; nephropore on left side normal, on fourth annulus (164), on right side far forward in the large third annulus (163). XXIII probably 10-annuate (173–182 left, 171–180 right), nephropore on fourth annulus (*c4* 176 or 174). Caudad of XXIII, counted as 10-annulate, are 19 annuli which constitute somites XXIV to XXVII inclusive, but there are no external criteria for determining their limits. Some annuli in the anal region are much larger dorsally and taper to little or behind 195 to nothing ventrally but this is due to the strong curvature ventrad. Color as preserved uniform dark slate above, paler below; according to Mr. Stirling black in life.

Description of the paratype.—The paratype was collected by Dr. Sumichrast (see footnote, page 261). When living it was probably almost as large as the type, but now it is more contracted and artifically more flattened and somewhat distorted. It measures in millimeters: length 78.2, to male pore 16; widths, buccal 2.5, male 7.5, maximum (middle of length) 12.2, anus 7.2, depths at same points 2.5, 6.5, 8.6, 4.5; diameter of sucker 6. Annulation and other characters agree with the type, but the areolation is largely smoothed out as a result of softening and abrasion of the surface due to long preservation. There are some minor differences. Eyes four pairs, arranged as in the type on somites III to VI, none detected on II and no supplementary eyes on VI. Male pore at XI *b4/c9* (annuli 43/44), the additional annulus being due to an extra pregenital one, apparently in VIII, which appears to have eight instead of seven as on the type, but this is compensated on XIII which is 9- instead of 10-annulate, with female pore at 62/63 (probably *b4/c9*) 19 annuli behind the male. Both genital pores are relaxed and large. Nephropores are

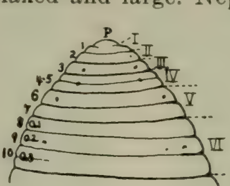

FIG. 2.—*D. magna:* type, segmentation of cephalic region from dorsum, semidiagrammatic; annuli numbered on left, somites on right side; *P*, prostomial lobe; ×5.

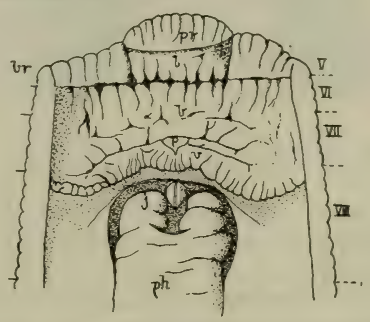

FIG. 3.—*D. magna*, dissection of buccopharyngial region of paratype, from the venter; *b*, buccal chamber laid open; *br*, buccal ring; *j*, right lateral jaw; *l*, lip; *p*, dorsal papilla; *ph*, pharynx; *pr*, prostomium; *v*, velum; somites numbered in Roman; ×6.

spaced exactly as on the type. None found on VIII and very doubtfully on IX but from X to XXIII they are evident, the first four being each separated by nine annuli, the fourth and fifth by 10, and the remaining nine pairs by 12 annuli, the last pair belonging to XXIV being united in a median opening at the base of the sucker. Anus at 194/195 followed by five annuli, making the total number 200. Owing to strong contraction the annuli for the most part are very narrow and crowded but on the dorsum are distinct and easily counted. In places, however, they are unequally contracted, and on the venter of the clitellar region are much split and interconnected.

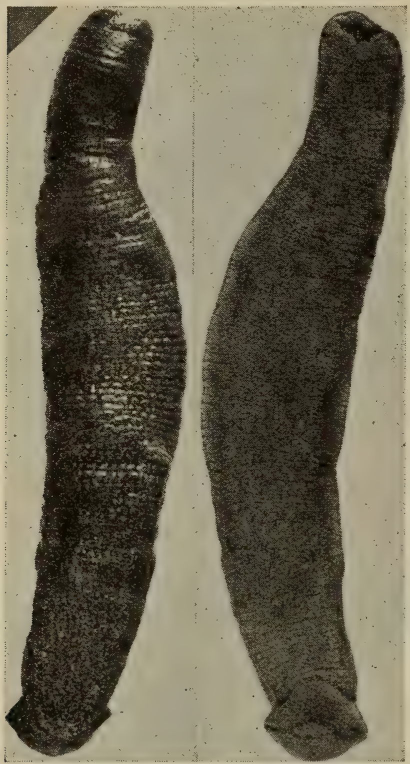

Fig. 4.—*Hirudinaria javanica similis,* n. subsp., dorsal and ventral views of type specimen; ×2.

Anatomy.—Neither specimen is suitable for complete anatomical study, and any dissection that might result in mutilation is prohibited because the specimens are unique. The pharyngobuccal region of the cotype was cautiously opened (Fig. 3), bringing to light conditions quite like those described by Cabellero (1940) for his *Hygrobdella pelaezi* = *Diestecostoma mexicana* (Baird, 1869) and in a forthcoming paper by the writer to be published by the Bishop Museum. The buccal chamber is spacious (Fig. 3*b*) and extends to the end of somite VII, where it is bounded by the velum (*v*). The inner surface is marked by a circular furrow, which delimits the buccal ring internally, and in its cephalic part by longitudinal furrows, some of which are continuations of those on the ventral face of the lip. These fade out in the caudal half where they are replaced by a few irregular, more or less branched wrinkles. The velum (*v*) is a prominent curtainlike diaphragm with deeply scalloped border forming the boundary between the buccal and pharyngeal chambers at VII/VIII. Immediately cephalad of it in the dorsomedian line is a soft triangular papilla (*p*) terminated by a short filiform process. The pharynx (*ph*) is a muscular organ lying in somite VIII and partly in IX. The cephalic end terminated by three lobes projects freely into an introverted pharyngeal chamber lined by a thin flexible membrane and obviously capable of limited protrusion somewhat as in the rhynchobdellid leeches but much less, although much more than in haemadipsines which show some approach to this condition. The three pharyngeal lobes are median dorsal and right and left ventral and each bears a small but prominent toothed jaw (*j*). Each jaw bears on a median ridge a series of teeth the form and number of which were not ascertained. On the type two ganglia of the ventral chain in complete somites XVII and XVIII were exposed through a cut that had been conveniently made at the time of collection. Relatively to the size of the leech they are small. As they lie in the two annuli immediately succeeding that on which the nephropores open they agree with the latter in fixing the position of the primary *a1* and *a2* components of complete somites. This, however, while helpful, does not certainly fix the limits of the somites which was done for the middle body region on the additional evidence supplied by the tendency of every alternate furrow to be somewhat deeper, thus uniting the tertiary annuli in pairs. The position of the nephropores in relation to the split annuli on somite XXII, as well as comparison of the 3 known species of the genus, also support the interpretation adopted herein. There are, however, two less probable interpretations than the one adopted in this paper. Until material for a complete anatomical study is available the exact interpretation of the annulation must remain uncertain.

Little is known of the life and habits of this leech. In a letter Mr. Stirling kindly writes that his specimen was found along with another of similar size in fairly dry earth a few inches beneath the surface while he was excavating a ball court in the forest. They impressed him as being black (probably dark slate color) and were dry and not covered with mucus, which is obviously true of the preserved specimen. The paratype must be at least 74 years old, as Francis Sumichrast made his collections in Tehuantepec in the late 1860's and early 1870's.

In *D. mexicana* (Baird), the genotype, the

first pair of nephropores, which in most leeches open on somite VIII, are carried forward by long ducts to open on the inner surface of the buccal ring, thus resembling the true land leeches (Haemadipsinae). In *D. mexicana*, also, there is evidence that the first and second pairs of nephridia are united and that the buccal outlet serves both. A similar condition in *D. magna* would explain the failure to find nephropores on both VIII and IX.

Genus **Hirudinaria** Whitman

Hirudinaria javanica similis, n. subsp.

Fig. 4

Material examined.—Four specimens, including the type (U.S.N.M. no. 20644). Collected at Yun Hsien, Yunnan Province, China, by W. L. Jellison, March 16, 1943. One specimen, labeled "Indian Museum, Z.E.V. 4871. Mainma Dist., N. Burma, Chinese frontier," collected by T. Rennie, June 10, 1911, from pool of water in which buffaloes wallow. This specimen was taken with a large number of *H. javanica javanica*, some of which had gonopores in intermediate positions.

Description.—Based upon these five specimens, this form is distinguished from typical *H. javanica* Wahlberg by the separation of the gonopores by nine instead of seven annuli, the male pore being at XI *a2/b5* (ann. 30/31) and the female at XIII *b2/a2* (39/40). In size, form, color pattern, annulation, arrangement of areolae, and other external characters there is complete agreement with typical *H. javanica*, but in a few respects, as in the position of the gonopores, this form seems to pass beyond the limits of variation of typical *javanica*. Among these is the number of sucker rays as counted at the margin, which is 53 or 54 in the specimens of *similis*, while 40 to 48 is most usual in *javanica*. However, this has little significance as some rays are entirely undivided, whereas others bifurcate two or even three times, the last division often appearing close to the periphery of the sucker. The sensillae appear to be relatively smaller but have the same distribution, elliptical form, and angular deviation from the body axis as in *javanica*. Two specimens dissected differ in respect to the female organs from those of *H. javanica* as described in *Fauna of British India—Hirudinea* (p. 217) in having much shorter oviducts and larger prostate glands. Other dissections of *H. javanica*, however, show variations in both respects partly bridging this gap. The salivary papillae on the jaws of one specimen studied are somewhat more numerous, there being on each side about 19 of the smaller size, mostly in a row close to the dentigerous ridge but a few on the jaw peduncle, and 15 of the larger scattered or in short irregular rows on the sides of the jaws. The former measure 0.029 to 0.037 mm and the latter 0.05 to 0.064 in a specimen of medium size.

The difference in the number of annuli separating the gonopores involves not one but two characters, as the positions of the male and female pores vary independently. In the collection of the Indian Museum are specimens of *H. javanica* in which either of these is shifted from the furrow somewhat into the bounding annuli (Moore, 1922, p. 212), the female pore tending to move to a more caudal, the male to a cephalic position, resulting in intermediates between the two subspecies.

Typical *H. javanica* is abundant in Assam and Burma, and present information indicates that in North Burma there is a tendency for the gonopores to separate more widely and that at the northward limit of the known distribution of the species in the Burmo-Chinese frontier area there is a population in which nine full annuli intervene.

The type of *H. j. similis* is an individual of medium size measuring, in millimeters: length 61, to male pore 13; widths, buccal ring 4.4, male 7, maximum (*ca.* XV) 11, anus 3.5; depths at same points *ca.* 3, 2.8, 3.5, 2.3; caudal sucker 7.

ICHTHYOLOGY.—Anchoviella analis, *a new engraulid fish from the west coast of Mexico.*[1]

ROBERT R. MILLER, U. S. National Museum.

During the World's Columbian Exposition in Chicago in 1893, the Mexican Government exhibited representative fishes, mostly from the fresh waters of central and southern Mexico. The specimens were subsequently preserved and donated to the United States National Museum. Among

[1] Published by permission of the Secretary of the Smithsonian Institution. Received May 25, 1945.

the many lots in this collection I found four engraulids which, because of a combination of very distinctive characters, are described below as new.

Genus **Anchoviella** Fowler

Anchoviella analis, n. sp.

Fig. 1

Generic reference.—In technical characters this species agrees with the genus *Anchoviella* and the subgenus *Anchoviella* as recently defined by Hildebrand.[2] Gill membranes narrowly attached anteriorly; teeth in jaws small and nearly equal in size; origin of anal fin nearly under that of dorsal fin; more than 15 gill rakers on lower limb of first gill arch; body deep and strongly compressed; anal fin base long; maxillary not reaching joint of mandible (but extending beyond posterior rim of orbit a distance about equal to diameter of pupil) and broadly rounded posteriorly, rather than pointed as in *Anchovia* and *Anchoa.* The size and shape of the maxillary form the principle character by which *Anchoviella* differs from *Anchoa.* Dr. S. F. Hildebrand has kindly examined the types and agrees that the species should be placed in *Anchoviella.*

Holotype.—U.S.N.M. No. 131168, a specimen 82 mm. in standard length, collected in Laguna de Mexcaltitan, Nayarit (formerly Territory of Tepic), Mexico.

Paratypes.—U.S.N.M. No. 130857, three specimens 60 to 74 mm. long, secured with the holotype and bearing the same data. All the types are somewhat shrunken.

The position of the type locality (shown on the American Geographic Society Map NF 13, Guadalajara, edition of 1940) is approximately 9 miles west-southwest of Tuxpan, which is nearly 39 miles northwest of Tepic. Mexcaltitan is a small settlement near latitude 23° N., longitude 105° 30′ W., on an arm of a lagoon which is connected to the Pacific by a meandering channel about 10 miles long. In 1893 this lagoon may have been called Laguna de Mexcaltitan; the original label with the fish read Laguna de Mezcaltitlan.

Diagnosis.—A deep-bodied, compressed *Anchoviella,* with a rather long maxillary (but not reaching to joint of mandible), and with a very long anal fin of 31 to 35 total rays (29 to 31 principal rays),[3] the origin of which is almost directly under that of the front of the dorsal fin.

Description.—In the following description the measurements and counts for the holotype are given first, followed by those for the three paratypes, in order of decreasing size. The method of presentation is essentially the same as that followed by Hildebrand (*loc. cit.*). The measurements were stepped off with a pair of fine dividers and are expressed as percentages of the various parts indicated, usually estimated to the nearest tenth and occasionally to the nearest hundredth.

Standard length in mm 82 (74, 64, 60); head in standard length 4.3 (4.1, 4.2, 4.2); width of body in its depth (measurement approximate) 4.1 (3.9, 3.8, 4.0); depth of body in standard length (measurement approximate) 4.1 (4.0, 4.1, 4.1); eye in head 3.3 (3.4, 3.4, 3.2); eye in postorbital 1.6 (1.6, 1.7, 1.5); post-orbital in standard length 8.2 (7.9, 8.0, 8.05); snout in head 5.4 (5.3, 5.1, 5.3); mandible in standard length 7.4 (7.2, 7.3, 6.75); mandible in head 1.75 (1.75, 1.65, 1.6); maxillary in head 1.75 (1.75, 1.65, 1.6); dorsal base in head 2.5 (3.0, 2.6, 2.8); anal base in standard length 2.6 (2.7, 2.7, 2.85); pectoral in standard length 5.6 (5.1, 5.45, 5.1); pectoral in head 1.3 (1.2, 1.3, 1.2); pelvic in head 2.5 (2.35, 2.4, 2.3); axillary scale of pectoral in head 2.8 (2.7, 2.65, 2.6); dorsal rays 13 (12, 13, 12); anal rays 35 (33, 35, 31); pectoral rays 12–13 (12-12, 13-13, 12-12); pelvic rays invariably 7; scales (approximate) 40 (39, 40, 38); gill rakers (above and below angle of first arch) 19+24 (19+23, 18+24, 19+24).

Body deep and strongly compressed, the thinness exaggerated by shrinkage. Ventral profile more curved than the dorsal. Head rather short and deep, its depth at joint of mandible about 1.3 to 1.4 in head length; snout short and bluntly pointed, projecting well beyond tip of mandible. Dorsal fin rather high and short, the anterior (longest) rays (broken in holotype) reaching far beyond tip of last ray when depressed, its origin equi-

[2] Bull. Bingham Oceanogr. Coll. 8 (2): 11–12, 108–109. 1943.

[3] In the enumeration of principal dorsal and anal fin rays, the first ray counted was the first long, unbranched ray, followed by branched rays; two rudimentary rays invariably precede this ray in both fins. In order to make the counts agree with those in the most recent review by Hildebrand, the total count was used.

distant between caudal base and some point on pupil; anal fin base long, its origin almost directly under that of dorsal origin and equidistant between caudal base and middle to posterior of pupil; pelvics small, extending more than halfway to anal origin, inserted about equidistant between anal origin and pectoral base; pectorals long, extending slightly beyond insertion of pelvics.

Color of specimens in alcohol dark brown, with a silvery band, which is rather wide anteriorly but narrow between dorsal and anal origins and is very narrow on caudal peduncle; its ventral margin is not clear-cut, but the greatest width of the band is about two-thirds to three-fourths the eye diameter. Rather fine, dark pigment spots on tip of snout, along ridge of back, base of dorsal, and a few along base of anal. Sides of head silvery, with a metallic bluish luster.

Relationships.—*Anchoviella analis* differs from any known American species of the genus in the long, many-rayed anal fin and in the anterior position of this fin. In number of anal rays it is closest to *nattereri* (Steindachner), described from Pará, Brazil, which has 28 or 29 (possibly 30 to 31 total rays). The new species differs prominently from Hildebrand's account of *nattereri* (condensed from Steindachner's description) in the much more anterior insertion of the anal fin (origin of anal about under middle of base of dorsal in *nattereri*), much shorter snout (5.1 to 5.3 rather than 4.0 in head), and in having the maxillary bluntly pointed (rather than nearly square) posteriorly. It is obvious that *analis* is not closely related to *nattereri*. Superficial resemblance is seen between *analis* and *pallida* (Starks), as figured by Hildebrand,[4] but *analis* has much fewer gill rakers (28 to 34+36 to 45 in *pallida*) and more anal rays.

Anchoviella analis much more nearly resembles certain species of the closely related genus *Anchoa*, notably *A. panamensis* (Steindachner), known from Mazatlán to Peru. It agrees with *panamensis* in the number of anal rays, the origin of the anal fin, the shape of the head, the compressed body, and the length of the pectoral fin but disagrees on the important character of the length and shape of the maxillary which, in *panamensis*, is slender and pointed and is much longer, 1.2 to 1.4 rather than 1.6 to 1.75 in the head length. The rather remarkable resemblances between *analis* and *panamensis* may be more real than superficial, however, and *analis* might be considered an aberrant *Anchoa*, with an exceptionally short, blunt maxillary. If that view were adopted, however, the principal generic difference between *Anchoa* and *Anchoviella* would fail and *Anchoa* would become a synonym of *Anchoviella*. To base such a move on the few specimens before me seems entirely unwarranted. Differences judged to be of generic value often lose their sharpness in borderline species.

Associates.—The following species were found wrapped in the same lot with the new species: *Anchovia macrolepidota* (Kner and Steindachner), *Anchoa lucida* (Jordan and Gilbert), *Diapterus peruvianus* (Cuvier), and a species of *Gobionellus*.

Etymology.—The new species is named *analis* because of the very long anal fin base.

[4] *Loc. cit.*, fig. 59, p. 134.

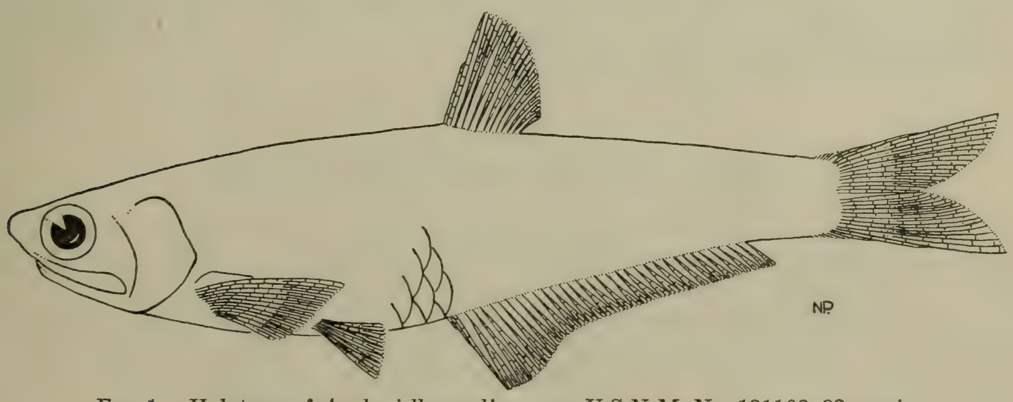

FIG. 1.—Holotype of *Anchoviella analis*, n. sp., U.S.N.M. No. 131168, 82 mm in standard length. Drawn by Nancy Patton.

Obituary

Merton Benway Waite, retired member of the Washington Academy of Sciences, died on June 5, 1945, after a short illness. He is survived by his wife, Elizabeth Hurdle Waite, and his two sons, Merton and Malden, both of whom are captains in the Army. Dr. Waite was born near Oregon, Ill., on January 23, 1865, of sturdy pioneer stock and was himself a pioneer in the application of botanical knowledge to the art of horticulture.

Waite entered the University of Illinois, presumably to become trained as a civil engineer, but his love and knowledge of plants and the influence of Prof. T. J. Burrell soon turned his major interest to botany, an interest that continued to the date of his last sickness. Following his graduation from the University of Illinois in 1887, he was assistant to Professor Burrell until November 1888 when he was induced to enter the old Division of Vegetable Pathology of the U. S. Department of Agriculture. He continued in this Division and in the Bureau of Plant Industry that suceeded it until his retirement in 1935. In 1919 the University of Maryland conferred on him the honorary degree doctor of agriculture. For many years he was in charge of the Office, later Division, of Fruit Disease Investigations and was an acknowledged authority on that subject. His discovery that the bacterium causing blight of pomaceous fruits was disseminated by insects was epoch-making because it was the first proof that a plant disease could be disseminated by insects and possibly antedated similar discoveries for animal diseases. He also developed and put in practice methods for the control of this disease which are still in use, particularly in the Pacific Coast States. He also contributed greatly to the development of control measures for many other destructive diseases of fruits. He discovered and by elaborate experiments showed conclusively that with certain varieties of pears and other fruits cross pollination is necessary for the setting of a full crop of fruit. This discovery resulted in changed planting plans of orchards throughout the world.

He helped organize and was for 14 years a member of the Federal Insecticide and Fungicide Board that administered the Insecticide Act of 1910. In 1924 he became a member of the Federal Horticultural Board, continuing until its quarantine functions were taken over by another agency.

Waite belonged to many scientific societies, but his favorite was the Botanical Society of Washington, of which he was twice president. He rarely missed a meeting and usually had interesting observations, often supported by specimens, to report. He was deeply interested in the flora of the Washington area and in his later years gave special attention to mosses. He was also an enthusiastic member of the Cosmos Club, seldom missing the Monday "club nights" even when living at his country place 25 miles away.

Dr. Waite was a man of restless energy and enthusiasm throughout his career, even to the day of his final illness. His pleasant smile and sociable nature endeared him to his colleagues and he was always willing to devote his time to the giving out of his large fund of knowledge. He was so full of life and so interested in living that it does not seem possible he is dead.

John W. Roberts

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ETHNOLOGY.—*Japanese folk belief concerning the cat.*[1] MORRIS EDWARD OPLER, Claremont Graduate School, Claremont, Calif. (Communicated by WILLIAM N. FENTON.)

In 1909, in a carefully documented paper, M. W. de Visser brought together all references to the cat which he could find in Japanese chronicles and classical writings.[2] His exhaustive review of the literature indicated that the small domestic house cat was imported from China during the reign of Emperor Ichijō (986–1011) though wild cats existed in Japan before this.[3] The possession of cats was at first a luxury which only the Imperial House and the wealthy nobility could afford, and a great deal of pomp and ceremony attended the crises in the lives of these pampered animals. Members of the court were ordered to serve them, and the rank of court lady was bestowed on one female cat.[4] By the fourteenth century, however, cats were no longer a rarity and they were no longer treated with deference. Instead, the belief had grown up that cats, especially old female cats, were capable of becoming monsters or demons (*nekomata*)[5] which harm or even kill men, and, to use De Visser's words, "the Japanese *nekomata* is an exceedingly dangerous demon."[6] De Visser found first mention that old cats become monsters and kill human beings in a work written by a Buddhist monk about 1335.[7] Unlike so many Japanese beliefs concerning the supernatural power of animals, the basic idea of the extraordinary power of the cat is not Chinese, though associated elements of the complex show Chinese influences. As De Visser has said: "We do not read about cat-sorcery in the former country (China) . . . I have not found this anthropophagous monster with its forked tail in Chinese books, but the idea of *old age* giving it the power of changing itself into an old woman is quite Chinese."[8]

From this time on, and particularly in the seventeenth, eighteenth, and nineteenth centuries, stories of old haunting cats are frequently found in the literature. In the nineteenth century, however, cats with extraordinary powers are sometimes represented as playing a beneficent or protective role.[9]

Although he does not organize them into a unified picture, the tales and references which De Visser recovered suggest the following body of beliefs: Cats can speak, that is, can become superanimal, at the age of ten. A cat that is a cross between a cat and a fox may have the capacity before it reaches this age. Some cats disappear mysteriously immediately upon the death of their owners, thus indicating some unusual relation between them and their masters. Cats which become supernatural often reveal themselves because they speak as human beings, because they are discovered acting like human beings (dancing, for ex-

[1] Received June 25, 1945.

[2] DE VISSER, *The dog and cat in Japanese folklore.*

[3] A well-informed young man who has lived and studied in Japan thinks otherwise and has asserted: "The cat came into Japan from Korea during the Nara Era."

[4] *Op. cit.*, p. 8; BRINKLEY, *A history of the Japanese people*, p. 277.

[5] The word *nekomata* literally means "cat forked." The "forked" refers to the tail; a divided tail is a sign that a cat is supernatural and dangerous.

[6] DE VISSER, p. 5.

[7] *Ibid.*, p. 21.

[8] *Ibid.*, p. 5.

[9] *Ibid.*, p. 77; MITFORD, *Tales of old Japan*, p. 243.

ample, with a towel tied around the head), because they have split tails, or because luminous balls or a peculiar light follows them when they move. Cats which are pinkish or reddish-brown in color, "golden flower" cats, are very likely to become monsters and must not be kept for any length of time. Those who are cursed by cats become ill, and a revengeful cat can drive mad a person it hates or the members of his family.

Cats which wish to prey upon human beings often assume human guise. A favorite trick is to kill a person, usually (though not always) an old woman, and to assume her form and take her place. Further victims are selected from this vantage point. The cat, whether in animal form or in human guise, ordinarily eats its victims, and only the buried bones and clothes are discovered afterward. Monster cats which are masquerading in human form sometimes arouse suspicion or are discovered by feline characteristics which they thoughtlessly exhibit, or which they find it difficult to conceal. Sometimes they forget to display the characteristics of the one whom they are impersonating. Thus, a cat may ignore religious devotions, though its victim has been a devout Buddhist and in this way attract attention. Or it may want to remain in a dark corner and may plead trouble with its eyes. In sleep, it may show the broad mouth of the cat, and it finds it hard to hide its large teeth and its rolling, distended eyes. It may be surprised eating on all fours or drinking oil from a lamp. It is always in danger of discovery despite its human appearance because dogs recognize its true nature. When a transformed cat is attacked and killed, it changes back to its original shape. Such slain cats invariably turn out to be very large, usually five *shaku* long (approximately five feet).

De Visser apparently made no attempt to add to the published material he collated or systematically to investigate the beliefs centering around the cat in the Japan of his day. The only items he adds to his summary of the literature are that the Japanese, like the Chinese, fear that a corpse will revive and change into a demon if a cat walks over it and therefore lay edged tools on the corpse or put a sword at its side,[10] and that a 3-colored cat (white, black, and brown) is a favorite of sailors and is often found aboard ships because its presence is thought to prevent storms.[11]

A number of other writers and scholars have called attention to Japanese attitudes toward the cat. On the occasion when De Visser's contribution was read, E. W. Clement made some comments which have been published with the paper and which yield some additional information on the subject. According to Clement, when the Japanese bury a dead cat, they do not look back at the grave for fear that they will be possessed by the spirit of the cat. Clement had also heard of monster cats with 3-forked tails (*mitsumata*).[12] He gave a number of illustrations of how fears or misgivings about the cat were reflected in Japanese expressions. He pointed out that the phrase "cat's eyes" means "fickle" or "changeable," that geisha girls, because of their role of shallow flatterers, are said to have "cat's tongues," and that insincerity in speech is referred to as the "cat's voice." Clement also pointed out that the term "cat's tail" is used of something particularly useless. This was given by him as the reason cats' tails are cut short.[13]

Even before De Visser wrote, A. B. Mitford had called attention to the important place of the cat in Japanese tradition with the statement: "Cats, foxes, and badgers are regarded with superstitious awe by the Japanese, who attribute to them the power of assuming the human shape in order to bewitch mankind."[14] Mitford published a story of a monster with two tails, "the Vampire Cat of Nabéshima," and another tale of an extraordinary but faithful and benign cat which saved the daughter of a household. All the elements in Mitford's account and stories have already been mentioned in our discussion of De Visser's paper.

Hearn, in his *Glimpses of unfamiliar Japan*, has a few interesting paragraphs

[10] De Visser, p. 77.
[11] *Ibid.*, p. 78.
[12] *Ibid.*, p. 79.
[13] *Ibid.*
[14] *Op. cit.*, p. 243.

about cats. Of a cat which roamed his grounds in Izumo he wrote: "Partly because of the immorality of this cat, and partly because it happens to have a long tail, it has the evil reputation of being *nekomata*, or goblin cat. It is true that in Izumo some kittens are born with long tails, but it is seldom that they are suffered to grow up with long tails. For the natural tendency of cats is to become goblins; and this tendency to metamorphosis can be checked only by cutting off their tails in kittenhood. Cats are magicians, tails or no tails, and have the power of making corpses dance. Cats are ungrateful. 'Feed a dog for three days,' says a Japanese proverb, 'and he will remember your kindness for three years; feed a cat for three years and she will forget your kindness in three days.' . . . Cats are under a curse: only the cat and the venomous serpent wept not at the death of Buddha; and these shall never enter into the bliss of Gokuraku."[15]

Anesaki recounts some tales which involve the cat, but he draws largely from the same literary sources which De Visser utilized and so does not add significantly to what we already know. His discussion of the interpretation of color in cats contains some variant information however, and is worth citing:

"The colours of the cat's fur had much to do with popular ideas about the creature. The most dreaded cat was a red or pinkish brown animal which was called the 'golden flower' cat. Then came a cat in which the three colours, black, white and brown were mixed. The magical powers of black or white cats were believed to be less remarkable, but a totally black cat was thought to have the power of foretelling the weather, and sailors were always glad to have one about their ship."[16]

More recent investigation has added little to our knowledge of Japanese lore concerning the cat. Embree, in whose study of a Japanese village social organization rather than religion is emphasized, has this reference to the cat: "If a man has been bewitched, he visits a *kitōshi*, who by prayer will drive out the possessing spirit. In Kuma this is mostly a dog's spirit, though sometimes that of a cat or a fox."[17]

Recently, while I was serving as community analyst of the War Relocation Authority at the Manzanar, Calif., Center for persons of Japanese ancestry evacuated from the West Coast, I had occasion to discuss some of the Japanese folk beliefs concerning animals with évacué friends and was able to secure a number of details and variant beliefs which, as far as I have been able to discover, have not been published, at least in English, before. The account which follows, which was given to me by a friend who wishes to remain anonymous, contains some of these details.

"The Japanese believe that a cat should never be kept more than three years. This is because after three years it can change and become anything it wants to. One of the first signs that a cat is taking on supernatural power is the splitting of its ears. If you see a very old cat you will notice that its ears are split. By the end of its third year a cat's ear is beginning to split.

"When a cat is brought into a Japanese house it is told, 'You can stay here only three years.' Therefore it goes away by itself after three years. At the end of the third year the cat is gone.

"The Japanese believe that the cat can bring good fortune or bad, depending upon its characteristics. The cat most highly prized for the house is one they call "three hair cat" (*mike neko*), a cat of three colors. It is a cat whose fur is black, whitish, and brown. Usually a cat has fur of only two colors. The cat of three colors is supposed to bring good fortune, though I must say that our family never had good luck because of such cats we had.

"Some people, mostly merchants, have a porcelain cat which is in a sitting position with the right paw lifted in a sort of beckoning gesture. They keep this right in the front part of their shops. It is supposed to bring in people, to draw trade. Therefore

[15] Pp. 368–69. Hearn apparently did not find out that the cutting off of the tail of a kitten was to prevent the tail from becoming forked and the grown cat from becoming a *nekomata*. Note the veiled warning in the Japanese proverb against keeping a cat longer than three years.

[16] "Japanese mythology," p. 327.

[17] *Suye Mura, a Japanese village*. p. 252.

a pretty girl clerk who brings in a great deal of trade is often called "beckoning cat" (*maneki neko*). Of a shop which is very busy we often say, 'They must have a good *maneki neko* in there.' Because of the power of cats to draw trade many merchants have a pet cat, especially a *mike neko*. It is believed that if the merchant has a good-luck cat the business will prosper and the owner will become very rich.

"But the cat is also very much feared because it is revengeful. Even after death it will do harm. This spirit of revenge of the cat is paradoxical because the cat also brings in trade. I will illustrate the cat's spirit of revenge by a story.

"There was a family that had a cat. One day the cat stole a fish from the kitchen. In a fit of anger the master killed the cat. No one thought much about it. They just thought that it was a pity and forgot about it. The cat was buried out in the yard. The next year the man who had killed the cat planted pumpkins in this yard. One vine was a fine one; it had just one pumpkin on it but this one was an especially fine and large one. It was the best pumpkin in the village. People came to admire it.

"After a while this man's family ate the pumpkin. This was a big family of seven or eight and they all died right after that. Because they suffered so before they died, one of the neighbors was suspicious. He thought it must be food poisoning. He found out that the family had eaten this pumpkin. So he dug up the vine. He discovered that the seed from which the vine grew had been planted right in the skeleton of the face of the cat, at the place where the mouth of the cat had been.

"There is another well-known story to illustrate how the cat takes revenge. This story is told about a feudal lord named Nabeshima.[18] This happened somewhere in southern Japan. It is a story about a cat which took revenge on the feudal lord because his master was killed by Nabeshima.

"Nabeshima liked to play *goh*.[19] He always played the game with a blind man, a certain woman's only son. This blind man had a pet cat. One time the feudal lord was in a bad humor. He lost several games to the blind man and then, getting very angry, decapitated him. When the news was brought to the mother of the dead man she told the cat, 'Your master has been killed. You had better do something about it.'

"The cat disappeared. That's all the mother knew about it. But shortly afterward the lord began to get sick. He couldn't sleep at night; he felt tortured; he was losing weight.

"A retainer who was very devoted to Nabeshima, who was always on guard before his door, and who even slept outside the door of the feudal lord, noticed that every time his wife went in to be with him he would start moaning and groaning. This retainer became suspicious of the wife and of her influence on his lord.

"Then, shortly after this, when the wife had just entered the room, the retainer noticed the shadow of a huge cat outlined against the sliding door. He struck at this shadow with a spear. The next day the wife didn't come to her husband's quarters. The explanation was given that she had slipped while taking a bath and had fallen in the tub and injured herself. The retainer began to think about it. He remembered that this woman had not cared for fish previously but that recently she wanted it three times a day.

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[18] This tale is recorded also by Mitford in *Tales of old Japan*, pp. 245–52. Mitford's version emphasizes the theme of the loyalty of a humble retainer rather than that of a cat's revenge. According to Mitford's account, a cat kills a beautiful concubine of a Daimyo and takes her place. The Daimyo falls seriously ill. Physicians can not discover the nature of his sickness. One hundred of his retainers resolve to keep watch over him but find that drowsiness overcomes them each night. A soldier of low rank but great devotion is found praying at a temple for the sick lord. Despite his low station, because of his piety he is allowed to stand guard as one of the one hundred. When he becomes sleepy, he sticks his dirk in his thigh and turns it. He is the only one to remain awake and thwarts the cat in human guise when she appears. He confides his suspicion of the concubine to officials and gets permission to kill her. During the fight that follows she turns into a cat again and escapes to the mountains. A great hunt follows in which she is killed. In *Suye Mura*, pp. 276–277, Embree gives two versions of this tale in outline.

[19] *Goh* is a game played with white and black "stones" or counters on a board of 361 squares. Each player tries to control as much space as possible by surrounding the counters of his opponent with his own. The game ends when the whole board is in use, and the winner is the one who controls the greatest area of the playing surface.

"He decided to keep an eye on the feudal lord's wife. This was hard to do because she had female retainers to take care of her and no men were allowed in her quarters. But one night he stole in these quarters and managed to get close to her without being discovered. He saw that she was licking the oil from the lamp. A cat's favorite drink is mustard seed oil. When he saw this the retainer knew that she was not a human being and struck at her. She escaped in the form of a cat. Then they dug under the quarters of the women and found the body of the wife. The cat had killed her and had taken her place. The retainer and others pursued the cat. The cat ran into an old abandoned temple. The cat mewed and other cats came. The place was alive with cats, for this one was a leader of the cats and had called for help. But finally this cat was cornered and killed, and after this the feudal lord got well again."

A second general account of the place of the cat in Japanese thought which was given to me helps to fill in our information and adds explanatory detail to points already mentioned.[20]

"They say a cat has great mental power (*jintsuryoku*). The way I have heard it, when a female cat becomes old, it can do evil things against man. Cats sometimes come out disguised as human beings. Since they have mental power equal to man's they can talk and act like a human being.

"These old cats seem to live in Buddhist temples. When they come out in disguised form it is always at night, according to the stories I have heard. When they are in a temple they don't want anyone to take the temple away from them. If anyone tries to open and use the temple again, the cats will disguise themselves as ghosts or monsters and scare him away. They take over the temple then. Such a temple, though deserted, is always kept clean. That is one way to tell a temple which has been taken over by cats.

"The Japanese word for monster is *bakemono*. Literally this means "what has come out." The Japanese word *bakeru* means "to turn into a monster." You can use this word of a badger or a fox, but then it implies that the badger or fox has changed form to play tricks or to do mischief. It is not very serious. But when you say a cat changes to a monster (*neko ga bakeru*), that is really dangerous.

"When the cat turns to a monster it may come out in the shape of a cat, but it is a huge cat. It has long nails and is fierce looking. It is ready to eat human beings. The ears of the monster cat are split.

"Ordinary people believe it is dangerous to kill a cat. They wouldn't take cats out and drown them as is done in this country. There is a saying, 'A cat which is killed reappears as a monster' (*neko o korosuto bakeru*). When a mother sees a child abusing a cat, a little child of six who doesn't know any better, she would say, 'If you kill that cat it will come out and annoy you at night.'

"There are stories to show what happens when you kill a cat. According to one story, a cat did something and the man of the house killed the cat. The cat came out as a *bakemono*. It began to persecute the man who had killed it. The man would always hear the crying of the cat and this made him restless. He became a sick man and had a nervous breakdown. He went on like this for several years and then passed away. The cat's spirit revenged itself on this man. Because of the man's death, his family went through great hardship.

"There are beliefs about cats of different colors. They say that the cat of three colors, white, black, and brown (*mike neko*), is the tame cat. A cat of that color is always going to be a family cat. The stories about cats which bother people are always about white or black ones. They leave the *mike* out of these. White cats are supposed to be old and wise. A monster cat is usually described as white. They don't like black cats in Japan either. They are considered evil and are said to bring bad luck.

"The Japanese have a feeling that the cat is greedy. It wants more and more. That is why they don't want it around after the third year. It tries to become a member of the house. There is a saying that goes something like this, 'After three years even a cat

[20] This account was contributed by Robert Seido Hashima, who lived and studied in Japan for many years. Mr. Hashima has also been good enough to read this paper, to check the Japanese terms, and to make a number of helpful suggestions.

becomes a member of the family.' I don't remember the exact words.

"In Japan I saw a moving picture which brought in some of these beliefs about the cat. It had to do with an old lady who kept a black cat more than three years. This woman was a heartless, grasping person, a *neko baba.* She didn't trust anyone but the cat. The way the cat cried would give the woman warning when she was in danger. The woman could understand the cat. The neighbors knew this woman was evil and hated the cat. They stayed away from the cat when they saw it; they were afraid something would happen if they went near it. This woman collected a great deal of money from the people by selling them things at high prices. They didn't dare to refuse to buy.

"One time the cat cried. It was trying to tell her something. But the old lady misinterpreted it. She struck the cat and didn't feed it for a while. The cat went away. The old lady got into trouble at once. She lost her fortune and got killed. The people never saw the cat again. They did not know where it went. This cat had brought her good fortune. Then when she didn't take care of it, it abandoned her and faded away.

"I have heard stories that tell how the farmers were harmed by cats. The cats would go out to farms and destroy vegetables or would come to the farmhouse and, while in the form of a human being, take food. Sometimes they took small children away with them. Usually these cats were living in some temple. The farmers then appealed to some samurai and asked him to kill the monster living in the temple. He would go out there and kill the cat, but he would have a hard time doing it because the cat would have a mental power as great as that of the samurai. When the cat was dead it was usually seen to be white.

"It is said that a person can be possessed by a cat. In such a case what happens seems to be tied up with the mental power of the cat. They say that the cat's mental power is stronger than that of the person. The cat doesn't get inside a person when it possesses him as the fox does. It influences him from outside.

"There are many beliefs about the cat in Kyoto and the area around Kyoto. I think this is because Kyoto is one of the oldest Japanese cities and has many temples connected with it. In ancient times Tokyo was one of the places that believed in cats strongly too. And there are other places where belief in cats is strong.

"Certain types of merchants and businessmen, I'm not sure what type, used to treat the cat well because they thought the cat brought them good luck in their businesses. Also I have heard that if you dream of a cat it will bring you good fortune.

"During the middle Tokugawas the dog was highly esteemed. Laws were even passed that anyone who killed a dog would be sentenced to prison for life. This kindness to domestic animals extended to the cat too. After this the cat became popular. But the treatment of the cat was not carried to extremes as in the case of the dog.[21] About this time the cat became the model of the woodcarvers. If a woodcarver carved a good cat he would be accepted as a real artist. It was a test. Any woodcarver who carried on his work would carve a cat. Skill in carving cats of wood was highly esteemed and a good example of this kind of carving brought a good price.[22] Such carvings were bought by rich people. There is not much carving of cats out of wood now, but there is a good deal of photographing of cats recently.

"One other thing about the cat. It is supposed to be very fierce in protecting its young. The Japanese say that a mother cat will eat her own kittens if she cannot protect them any longer, rather than to let them fall into the hands of an enemy.

"There are a number of common expressions which show how the cat is regarded. A wheedling, whining voice is called *neko nade goe* which literally means 'cat brush against voice.' An old lady who misuses or

[21] For an account of these laws and the "dog mania" of the Shogun Tsunayoshi who began his term of office in 1680, see BRINKLEY, *A history of the Japanese people,* pp. 602–03.

[22] The "sleeping cat" in the mortuary chapel of Ieyasu at Nikko by the Japanese artist Hidari Jingorō is the most famous example of its kind. See CHAMBERLAIN, *Things Japanese,* pp. 63–64, 262, and REIN, *The industries of Japan,* p. 420.

makes a profit on young people or who is in general unscrupulous and grasping is called 'old lady cat' (*neko baba*).[23] Of a person who is quiet and polite but who does evil behind people's backs (a hypocrite), it is said, 'he wears a cat' (*neko wo kaburu*). 'He's like a cat' (*neko noyōna hito*) is said of a person who is not trusted. 'To change like a cat's eye' (*neko no me noyōni kawaru*) is to be fickle and untrustworthy and to change a thing to one's own advantage.

"I haven't heard of cats doing harm to people in recent times. Most of these stories are told about former times."

On the basis of the research carried on at Manzanar and since, a number of elements have been found which may be added to what we already know concerning Japanese beliefs and folklore concerning the cat. These may be summarized briefly as follows: Cats are in general greedy and overreaching. They try to win their way into the family circle and dominate it. It is dangerous to keep a cat longer than three years. Even if a cat does no noticeable harm, after this period it will be so independent that it will render no service.[24] When a cat's ears begin to split, it is a sign that it is beginning to take on supernatural characteristics.[25] Supernatural cats tend to frequent and utilize abandoned temples. They are difficult to oust and are capable of possessing and deceiving man because of their unusual mental power. Though cats appear in human guise, their shadows, when seen through a sliding door, are always feline. White color of the fur is a sign of age, power, and wisdom in a cat, and monster cats, when slain, are often found to be white.[26] Concepts of hypocrisy, greed, and fickleness are often expressed in the Japanese language through references to the cat or to cat-like qualities. There is evidently some difference of opinion or local variation concerning the color of the cat which is the favorite and helper of sailors. The attributes of the 3-colored or "calico" cat have been variously explained also. In spite of the fear that it has aroused, the cat is a benefactor of merchants, has had a prominent place in art, and has been pictured as a fearless defender of its young, even to the point of destroying them when it is unable to safeguard them longer.

If this limited inquiry, carried on under unfavorable conditions and in spare time, has yielded so many additional details, it may be assumed that systematic and sustained research would contribute much more to our knowledge of Japanese folklore and folk belief concerning the cat. Problems of local variation, according to ken or district, evidently require much more attention than has hitherto been given them.

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[23] The proprietress of a house of ill fame is often called by this term. According to Clement, *neko baba* means "anything concealed," literally "cat's dung."

[24] On this point I was told, "You usually keep a cat to catch mice or rats. But after the third year a cat won't catch any more mice. So from a practical point of view it is useless to keep it."

[25] This is probably a variation on the "forked tail" theme and may have only local distribution in Japan.

[26] The persistence of the belief concerning the animal form of the shadow and the associations of the color white are also found in connection with other animals which are feared. Compare the data in other papers by Opler cited in the bibliography.

BOTANY.—*The vegetative characters of the bamboo genus* Phyllostachys *and descriptions of eight new species introduced from China.*[1] F. A. McClure,

Office of Foreign Agricultural Relations and Smithsonian Institution.

INTRODUCTION

This paper represents a portion of the results of accumulated observations that were being correlated (under a Fellowship granted by the John Simon Guggenheim Foundation) in a comprehensive treatment of *Phyllostachys* and other Chinese bamboo genera. That study was interrupted shortly after the outbreak of hostilities in the Pacific area, and attention was turned to more urgent work on Western Hemisphere bamboos on behalf of the United States Government.

The occasion for hastening the publication of this part of the study is the special emphasis that the present emergency has given to the importance and industrial promise of this genus for Western Hemisphere economy. The genus *Phyllostachys* supplies the bulk of all the industrial bamboo culms and the edible bamboo shoots utilized in China and Japan and also practically all the bamboo culms exported by Japan to this country in pre-war times. The young shoots of the bamboos of this genus are, without exception, edible. Moreover, their full-grown culms are known to be an excellent source of paper pulp. It is estimated that 80 percent of all the paper consumed in China comes from this genus. Recent special experimental studies carried out in the United States indicate that bamboos of this genus are entirely suitable, technologically, for the manufacture of Western types of paper by modern methods.

Bamboos of this genus thrive in well-watered, warm-temperate areas such as comprise much of our west coast, our east coast south of Washington, D. C., and the Gulf States (excluding parts of Florida), and similar areas in Latin America, where bamboos of the more cold-sensitive tropical genera cannot be grown.

Living plants of the principal species of *Phyllostachys* used in China and Japan are already available in this country. Some of these have been growing here for nearly 40 years without having been given a comprehensive trial or special study. The U. S. Department of Agriculture has living plants of 21 species and 4 recognized forms or varieties in this genus. Of these, apparently only 11 species and 3 varieties have been formally described and given scientific names. It is assumed that making available a knowledge of the distinctive characters of the individual kinds for purposes of identification, and providing valid, documented names where these are lacking, will help to focus interest on the species of this genus, encourage experiments in their cultivation, and stimulate scientific investigations of their technological properties.

Eight of the ten aforementioned species presumed to be new are here described. The available plants of the other two are as yet too young to show fully their distinctive characters. A more comprehensive treatment of the genus, embracing all the species under cultivation in this country, with keys for use in field identifications, is under preparation.

The descriptions are based on field observations of the living plants, and the characters used are drawn from the vegetative organs. The characters of these structures, particularly those of the nodes and internodes of the culm itself, and the culm sheaths, are quite as distinctive as the characters of the traditionally used reproductive organs (flowers and fruits) and have the advantage of being available for purposes of field identification.

The measurements of the parts of the culm sheath and the leaves are based on dry material. The Roman numerals appearing in the descriptions refer to the serial number (within the respective series) of the culm node, internode or sheath (as the case may be), counting as "I" the first one above the ground level in the series of a given structure.

The P.I. number, under which the pedigree of each introduction is published in the Plant Inventory of the Division of Plant

[1] Received April 10, 1945.

Exploration and Introduction, is given for each species. The reader is enjoined to caution, however, in the use of these numbers as means of identifying bamboos in the field. In the course of time labels often become inadvertently transferred. Identifications should always be verified by reference to published descriptions giving vegetative characters, or by having specimens (particularly representative culm sheaths) compared with the types or authentically named reference specimens.

The bamboos here described were all introduced into this country from China. They have been established and propagated at the field stations of the Division of Plant Exploration and Introduction, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. Most of them have also been grown by E. A. McIlhenny in his bamboo garden at Avery Island, La.

Much of the preliminary study of this genus was done in the Bamboo Garden established by the writer in 1925 at Lingnan University, Canton, China. Invaluable assistance has been given through the years by R. A. Young, assistant horticulturist, Division of Plant Exploration and Introduction, and by David Bisset, chief scientific aid in charge of the Barbour Lathrop Plant Introduction Garden, Savannah, Ga., in making the permanent plantings at the Garden available for study. Through the courtesy of Dr. W. R. Maxon, curator of the U. S. National Herbarium, and Mrs. Agnes Chase, custodian of grasses, the writer has had not only the necessary storage and laboratory facilities but also access to the types and type collections of bamboos preserved there. The types of the species here described will be deposited in the U. S. National Herbarium.

The illustrations show inner and outer aspects of the apex and blade of representative culm sheaths from lower, middle, and upper levels of mature-sized culms. The scale is ×1. My pencil sketches were inked by Agnes Chase.

No effort has been spared to make the descriptions accurate and adequate, but it will not be surprising if, in describing such extremely variable and inadequately known plants as these, some omissions have occurred or errors in detail have escaped detection. Notices of needed corrections will be gratefully received.

The bamboo plant is a complex organism that, like most woody perennials, takes a number of years to reach mature stature. During this developmental period the vegetative structures, particularly the culm sheaths, usually assume a more or less generalized form, and in most species it is only as the plant approaches mature stature that these structures exhibit the characters by which the different kinds may be distinguished with confidence.

The descriptions and figures here presented are based on plants presumed to have reached their approximate mature stature. The reader is cautioned against trying to use them to identify plants of immature stature. It must be remembered, too, that there is a certain degree of variation in any array of examples of a given structure, even where these are all taken from a single plant. Moreover, the internodes, nodes, branch complements, and culm sheaths, from the different levels in the culm, show different forms. It should not be surprising, then, if it should prove difficult to identify specifically a single example taken at random from the series. Foliage specimens alone are usually of little or no value for purposes of specific identification.

The most useful single organ is the culm sheath. But an adequate specimen should include examples (from the same culm if possible) representing the basal, middle, and upper part of the series, and so labelled. Next in importance for purposes of identification (when used in conjunction with the culm sheaths) are specimens of the lower one or two meters of the mature culm itself. The branch complement, and internodes within the branched part of the culm, are principally useful for generic identifications. Finally, the more completely the specimen represents the plant, and the more adequate the supplementary notes, the more reliable the identification may be.

VEGETATIVE CHARACTERS OF PHYLLOSTACHYS

Clump habit dumetose (thicketlike), actively spreading, open to more or less densely crowded; *rhizomes* indeterminate (advancing indefinitely underground), slender, with short internodes and more or less swollen nodes, every node gemmiferous (bearing a bud); *culms* arising from buds on the rhizome usually more or less distantly spaced, erect or suberect, never climbing; *internodes* of the culms hollow, cylindrical or nearly so above, the lower nodes, when these have no buds or branches, sulcate (with a broad groove) from base to tip above gemmiferous or branching nodes, usually with a narrow, more or less copiously farinose zone just below each node; the *nodes* of the culm all bearing branches in culms of very young plants (i.e., of juvenile stature), those in the lower half or so of the culm typically without buds or branches in culms arising from plants of mature stature, the nodes (at least the branch- or bud-bearing ones) double, i.e., with a distinct ridge encircling the culm just above the more or less prominent sheath scar; *culm sheaths* promptly deciduous, the ligules and blades progressively longer in sheaths at higher nodes of the culm; branch buds usually present at all of the nodes in small culms, especially those from young plants, lacking at the lower nodes (often half or more of the complete series) of culms of mature size from mature plants, but always present at all of the upper nodes, all usually developing very promptly, but one to several of the lower in the series *very rarely* (as, for example, in *Phyllostachys propinqua*) remaining dormant after the culm sheaths have fallen; *branches* often solitary in the lower part of the series, otherwise typically two at each node, the two usually more or less strongly unequal, with a third, usually very much smaller, sometimes developing between the two (atypically, and rarely, in exceptional culms, the branches clearly ternate, with the strongest one in the middle); *leaf blades* lanceolate to linear-lanceolate, with clearly tessellate venation, i.e., with transverse veinlets clearly visible at least on the lower surface, the lower surface usually manifestly paler than the upper surface and often definitely glaucous.

Phyllostachys angusta, sp. nov.

Species staturae inferioris internodiis culmi comparate elongatis, auriculis et setis oralibus in vaginis culmi haud evolutis, vaginis culmi et in apice et in ligula et in lamina angustissimis insignis. Species in notis nonnullis simulans *Ph. flexuosam* Riv. sed in characteribus saltem sequentibus distinguenda: culmorum internodiis primo vix (dempta zona angusta infra nodos) farinosis, ligula vaginarum culmi longe fimbriata haud purpurata, auriculis setisque oralibus in vaginis foliorum saepe haud evolutis.

Culmi usque ad 3.5 m alti et (int. V) 13 mm diametro, omnino glabri; *internodia* primo viridia nitidaque, deinde sensim levissime farinosa, usque (no. IX) ad 191 mm (V: 163 mm) longa, *ligno* circ. 3 mm crasso; *nodi* prominuli; *vaginae culmi* oblongae vel lineares, apicem versus leniter angustatae, dorso vulgo omnino glabrae, saepe (demptis plantis immaturis) sparsim fusco-maculatae, omnes siccitate pallide stramineae, conferte nervosae et coriaceae; *auriculae* et *setae orales* haud evolutae; *ligula* longe exserta (haud decurrens) angusta, dorso subtiliter strigosa, apice (interdum plus minusve oblique) truncata, margine vulgo undulata (in vaginis superioribus saepe lacerata) in vaginis inferioribus ciliata, in superioribus cum processibus scabris fimbriata, fragilis et vulgo mox diffracta; *lamina* anguste linearis, plerumque plus minusve patens (infimis raro valde reflexis), plana vel siccitate saltem plus minusve alveata, utrinque subtiliter scabra, secus margines antrorse scabra. *Rami* ramulique plerique 3-, raro 4-foliati, dempto internodio ultimo glabri, vaginis ramorum ramulorumque saepe plus minusve valde scabris. *Foliorum vaginae* pleraeque hispidulae, infimae glabrescentes; *auriculae* et *setae orales* et in ramis primariis culmorum hornotinorum et in culmis humilibus vel praesertim robustis interdum plus minusve valde evolutae, alioquin saepe haud evolutae; *ligula* longe exserta, dorso subtiliter hispidula, apice arcuata, margine valde undulata, in ramis ramulisque culmorum hornotinorum vulgo dense ciliolata, alioquin vulgo vix vel haud ciliolata; *petiolus* in ramis ramulisque culmorum hornotinorum vulgo utrinque glaber vel supra subtiliter puberulus; *laminae foliorum* usque ad 130 mm longae et usque ad 18 mm latae, lineari-lanceolatae, supra semper glabrae et nitidae, subtus vulgo ima basi hirsutae, alioquin secundum aetatem plantae pervariabiliter pubescentes, margini-

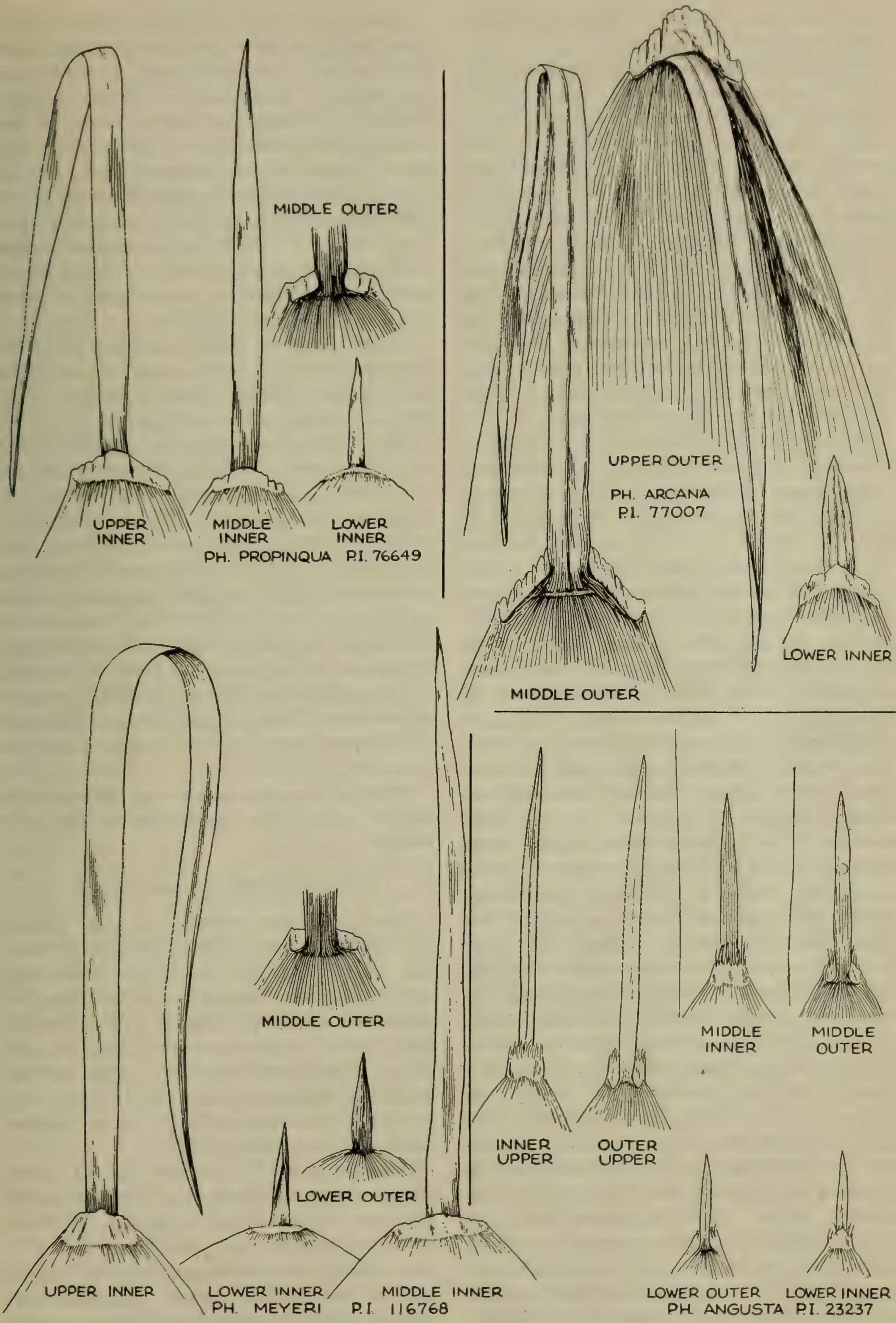

Fig. 1.—New species of *Phyllostachys.*

bus vel utrisque spinulosis vel altero ab initio glabro. *Inflorescentia* ignota.

This rather small species is distinguished by the following characters: Unusual length of internodes in relation to the diameter of the culm, their almost complete lack of white powder, the very narrow apex, ligule, and blade of the culm sheath, the fimbriate margin of the ligule in the upper culm sheaths, and the lack of auricles and oral setae in the culm sheath.

Species resembling *Phyllostachys flexuosa* Riv. in some characters but distinguished by the very narrow apex, ligule, and blade of the culm sheath, by the prominently fimbriate margin of the ligule in the upper culm sheaths, and by the almost complete lack of white powder on the internodes of the culm.

Culms up to 3.5 m tall and (int. V) 13 mm in diameter, glabrous throughout; *internodes* bright green and shining at first, then very lightly, almost imperceptibly, farinose, up to (no. IX) 191 mm (V: 163 mm) long, the *wood* about 3 mm thick; *nodes* moderately prominent; *culm sheaths* oblong or linear, gently narrowed toward the apex, usually entirely glabrous on the back, sparsely maculate (except in very young plants), pale stramineous, thin, tough and rather prominently ribbed when dry; *auricles* and *oral setae* lacking; *ligule* long-exserted, not at all decurrent, very narrow, obscurely strigose on the back, the apex (often more or less obliquely) truncate, the margin irregularly undulate (in the upper sheaths often lacerate), ciliate in the lower sheaths, fringed with scabrous processes in the upper ones, fragile and commonly soon broken; *sheath blade* narrow, linear, ascending (the lower ones rarely strongly reflexed), flat or, at least when dry, more or less trough-shaped, obscurely scabrous on both surfaces, scabrous along both margins. *Branches* and twigs usually 3-, rarely 4-foliate, glabrous with the exception of the uppermost internode, the branch sheaths and twig sheaths often more or less scabrous to the touch. *Leaf sheaths* mostly hispidulous, the lower ones glabrescent; *auricles* and *oral setae* more or less well developed in culms of the current year or in small or especially robust plants, otherwise often not developed at all; *ligule* long-exserted, obscurely hispidulous on the back, the apex arched, the margin strongly irregular, in leaves of branches and twigs of the current year usually densely ciliolate, otherwise scarcely or not at all ciliolate; *petiole* in leaves of branches and twigs of the current year, usually densely puberulent on both the upper and the lower surface, otherwise glabrous on both surfaces or obscurely puberulent on the upper surface; *leaf blades* up to 130 mm long and up to 18 mm broad, linear-lanceolate, always glabrous on the upper surface, commonly hirsute at the base, otherwise of variable pubescence on the upper surface, according to the age of the plant, both margins spinulose or one glabrous from the first. *Inflorescence* unknown.

TYPE: McClure 21023, collected May 30–August 3, 1942, at the Barbour Lathrop Plant Introduction Garden near Savannah, Ga., from permanent plot no. 11 (section C).

This bamboo was originally introduced into this country from China by Frank N. Meyer. It appears in the Plant Inventory of the Division of Plant Exploration and Introduction under P.I. 23237, where the following facts concerning it are recorded from the original field notes: The propagating material was secured in the autumn of 1907 from the vicinity of Tangsi, Chekiang Province, where the plant is known by the name *Sah Chu* (Mandarin), i.e., Stone Bamboo, on account of the hardness of the stems. These are described as being used in China principally for the manufacture of fine furniture.

The specific epithet alludes to the relatively narrow apex, ligule, and blade of the culm sheath.

Phyllostachys arcana, sp. nov.

Species insignis culmis omnino copiose farinosis glabrisque, nodis prominentibus, auriculis et setis oralibus in vaginis culmi haud evolutis, ligula vaginarum culmi longa et valde arcuata, saepe longe et anguste decurrens, lamina vaginarum culmi haud vel vix crispa. Species valde affinis *Ph. nudae* McClure sed ligula vaginarum culmi valde arcuata et in vaginis saltem inferioribus longe et anguste decurrente clare distinguenda.

Culmi usque ad 7.5 m alti et (int. V) 29×31 mm diametro, omnino copiose farinosi, glabri; *internodia* tactu striata, usque (no. XVI) ad 305 mm (V: 265 mm) longa, *ligno* (int. V) 4 mm crasso; *nodi* valde prominentes; *vaginae culmi* apicem versus sensim angustatae, in plantis staturae maturae vulgo cum maculis

fuscis sparse obsitae, superioribus interdum fere immaculatis, saepe tactu omnino laeves sed interdum (saltem in parte superiore, in culmis humilibus fere omnino) inter nervos validos cum papillis vel unguellis antrorsis asperae, interdum in medio culmi apicem versus (circa basin laminae) pilis mollibus plus minusve dense pubescentes; *auriculae* et *setae orales* haud evolutae; *ligula* dorso antrorse scabra (saepe dense et minute puberula) apice valde arcuata, secus marginem undulatam ciliolata fragilissima mox diffracta, alioquin pervariabilis: in vaginis inferioribus et in medianis, saepe infra basin et anguste et longe decurrens, in superioribus valde exserta; *lamina* patens, plus minusve alveata undulansque, in superficie abaxiale scabra, in adaxiale glabra vel subglabra, secus margines subtiliter scabra vel subscabra, eis in vaginis infimis brevibus plerisque subcordatis vel lanceolatis, interdum valde reflexis, superioribus lanceolata-linearibus, patentibus, glabris. *Rami* ramulique glabri, plerique 2–3-foliati. *Foliorum vaginae* (dempto ultimo pubescente) glabrae vel glabrescentes; *auriculae* et *setae orales* haud evolutae nisi forsitan in plantis juvenilibus; *ligula* longe exserta, dorso scabra, apice arcuata, margine fere glabra vel subtiliter ciliolata; *petiolus* supra versus basin vulgo puberulus, alioquin omnino glaber; *foliorum laminae* lanceolatae vel lineari-lanceolatae, usque ad 154 mm longae et usque ad 20 mm latae, plerumque multo breviores angustioresque, utrinsecus glabrae (in culmis humilibus vel senescentibus interdum subtus setulosae) secus marginem alterem omnino glabrae, secus alterem scabrae. *Inflorescentia* ignota.

Species distinguished by the following characters: Culms glabrous throughout and copiously farinose, the nodes prominent, the long, strongly arched ligule of the culm sheath often long and narrowly decurrent in the lower sheaths and not at all or scarcely so in the upper ones. Species closely resembling *Phyllostachys nuda* McClure, from which it may be distinguished by its strongly convex culm sheath ligule which, in the lower sheaths, is often narrowly decurrent far below the base of the sheath blade.

Culms up to 7.5 m tall and (int. V) about 29×31 mm in diameter, entirely glabrous, conspicuously farinose with loose white powder, especially immediately below the nodes; *internodes* up to (no. XVI) 305 mm (V: 265 mm) long, the surface perceptibly ribbed, the *wood* about 4 mm thick; *nodes* rather prominent; *culm sheaths* oblong to linear, gently rounded toward the apex, the lower ones commonly bearing some small dark spots, the upper ones often entirely immaculate, glabrous to the touch or often (at least in the upper part) scabrous between the crowded veins, those in the middle of the culm often pubescent at and near the base of the sheath blade, tough and husklike though easily split when dry, the veins then very prominent and close together; *auricles* and *oral setae* not at all developed; *ligule* scabrous on the back (often densely and finely pubescent) the apex strongly convex, ciliolate along the undulate margin, very fragile and soon more or less broken, otherwise quite variable: in the sheaths at the lower and median levels of the culm often narrowly decurrent far below the base of the sheath blade, at the upper levels strongly exserted and usually not markedly decurrent; *sheath blade* more or less patent, trough-shaped and undulate, scabrous on the abaxial surface, glabrous or subglabrous on the adaxial surface, obscurely scabrous or subglabrous along the margins, those on the lower sheaths very short, cordate or lanceolate, sometimes strongly reflexed, those on the upper sheaths lanceolate-linear. *Branches* and twigs glabrous, usually 2–3-foliate. *Leaf sheaths* (excepting the uppermost which is more or less pubescent) glabrous or glabrescent; *auricles* and *oral setae* not at all developed; *ligule* long exserted, scabrous on the back, convex at the apex, glabrous or obscurely ciliolate along the margin, very fragile and soon more or less broken; *petiole* puberulent on the upper surface near the base only, otherwise entirely glabrous; *leaf blade* up to 154 mm long and up to 20 mm broad, usually glabrous on both surfaces (sometimes setulose on the lower surface in old culms) entirely glabrous along one margin, scabrous on the other. *Inflorescence* unknown.

TYPE: McClure 20980, collected April 29, 1941, at the Barbour Lathrop Plant Introduction Garden near Savannah, Ga., from permanent plot no. 32 (section C).

This bamboo was originally introduced into this country from China in 1926 by the writer while acting as agricultural explorer for the U. S. Department of Agriculture. It appears

in the Plant Inventory of the Division of Plant Exploration and Introduction under P.I. no. 77007, where the following facts concerning it are recorded from the original field notes: Propagating material, in the form of rhizomes with culms attached, was secured November 3, 1926, under the name *Lao Chu* (Mandarin) or *Lo Chuk* (Cantonese) at (Pe Ssz Kung) Chihwashan, Anhwei Province, where it was observed both in the wild and under cultivation. A height of 4–6 m and a diameter of 2–2.5 cm were recorded for the culms. The shoots are said to be edible, and the culms are used in weaving (for matting) and for making lanterns.

The specific epithet alludes to the obscurity of reliable characters which made it difficult at first to distinguish this from *P. nuda*.

Phyllostachys aureosulcata, sp. nov.

Species insignis internodiis culmi et ramorum hornotinorum (in plantis staturae maturae) ab initio scabris, sulcis cum colore aut lutea aut viridi-aureo omnino in striis tinctis; vaginis novellis culmi saepissime cum striis albidis, luteis, viridibus et vinaceis notatis, eisdem etiam in statu siccato ut striis dilute- et fuscostramineis permanentibus; auriculis vaginarum culmi vulgo validissime evolutis excurrentibus, ligula ampla apice valide arcuata, lamina latiuscula vix crispa. Species in notis nonnullis simulans *Ph. nidulariam* Munro sed in characteribus sequentibus distinguenda: internodiis culmi ramique in sulco cum colore lutea vel viridiaureo tinctis; internodiis culmorum hornotinorum (saltem staturae maturae) scabris; vaginis culmi vulgo omnino glabris, texturae tenuioris; ligulis vaginarum culmi longioribus; cicatricibus in nodis culmorum minus prominentibus et semper omnino glabris; internodiis comparate brevioribus et nodis minus prominentibus.

Culmi usque ad 7.8 m alti et (int. V) 29 mm diametro; *internodia* usque (no. XIII) ad 356 mm (V: 196 mm) longa, primo (praesertim in parte culmi inferiore) plus minusve copiose farinosa et retrorse scabra, in sulco colore aut lutea aut viridi-aureo (vel omnino vel in striis) tincta, alioquin primo viridia deinde sensim olivacea vel (saltem culmis valde insolatis) aurescentia; *nodi* glabri, prominuli; *zona farinosa* vulgo cicatricem superans; *vaginae culmi* oblongae, versus apicem plus minusve late rotundatae, texturae tenuis lentaeque, colore variabilis, semper cum striis albidis, luteis et (praesertim versus basin culmi) vinaceis et (praesertim in parte culmi superiore) viridibus, (his et porro etiam in statu siccato cum striis et dilute- et fuscostramineis permanentibus) plus minusve valide notatae, primo copiose et laxe (in plantis staturae immaturae leviter) farinosae, infimis basi interdum (rarissime) retrorse scabris, alioquin omnibus omnino glabris; *auriculae* interdum in eodem culmo pervariabiles, in vaginis 4–5 infimis vulgo haud evolutae, alioquin vulgo valde evolutae, falcatae vel ovatae, raro omnino debiliter vel haud evolutae, vulgo e basi laminae decurrentes, interdum e basi laminae distinctae, saepissime plus minusve excurrentes, interdum reflexae, interdum novellis vinaceotinctis, in sicco tenues, fragiles, stramineae, plus minusve crispae; *setae orales* paucae vel plures vel quum auriculis nullis tum haud evolutae, vulgo in margine exteriore auricularum confertae; *ligula* usque (in V) ad 3–4 mm longa, superioribus gradatim longioribus, dorso subglabra, apice valde convexa, margine undulata cum ciliolis minutis et setis crassis scabris fimbriata; *lamina* erecta vel (in vaginis infimis) interdum reflexa, anguste triangulata, ima basi utrinque latescens, plana vel revoluta, haud crispa superficie adaxiali subtiliter scabra, abaxiali valde scabra, marginibus spinulosa. *Rami* omnino glabri vel in internodiis infimis plus minusve asperi, interdum plus minusve farinosi, 3–5-foliati, in culmis hornotinis omnino glabri, in culmis annorum plurium internodiis supremis interdum in sulco puberuli. *Foliorum vaginae* glabrae vel raro sparsim setosae; *auriculae* et *setae orales* pervariabiles, in ramulis parce foliatis debiliter evolutae, in ramis ramulisque plurifoliatis vulgo valde evolutae; *ligula* usque ad 1.5 mm longa, dorso basin versus sparse puberula, apice valde arcuata, margine undulante sparse ciliolata; *petiolus* utrinque glaber vel subglaber; *foliorum laminae* usque ad 155 mm longae et usque ad 19 mm latae, vulgo multo breviores et angustiores, supra glabrae, subtus ima basi dense pilosae vel hirsutae, in medio sparse pilosae, apicem versus obscure scabrae, spinulis marginalibus eximie remotis et patentibus. *Inflorescentia* ignota.

Species marked by the following conspicuous characters: The sulcus of the internodes of the

culms and branches at first tinted or striped more or less conspicuously (some would say obscurely) with yellow or greenish golden, especially during the first year; the culm sheath always more or less conspicuously color-striate in varying degrees of intensity at various levels of the culm, with white, cream, green, and wine, while fresh, and retaining visible variegation in light and dark tints of straw when dry. In the shape and coloration of the culm sheaths and

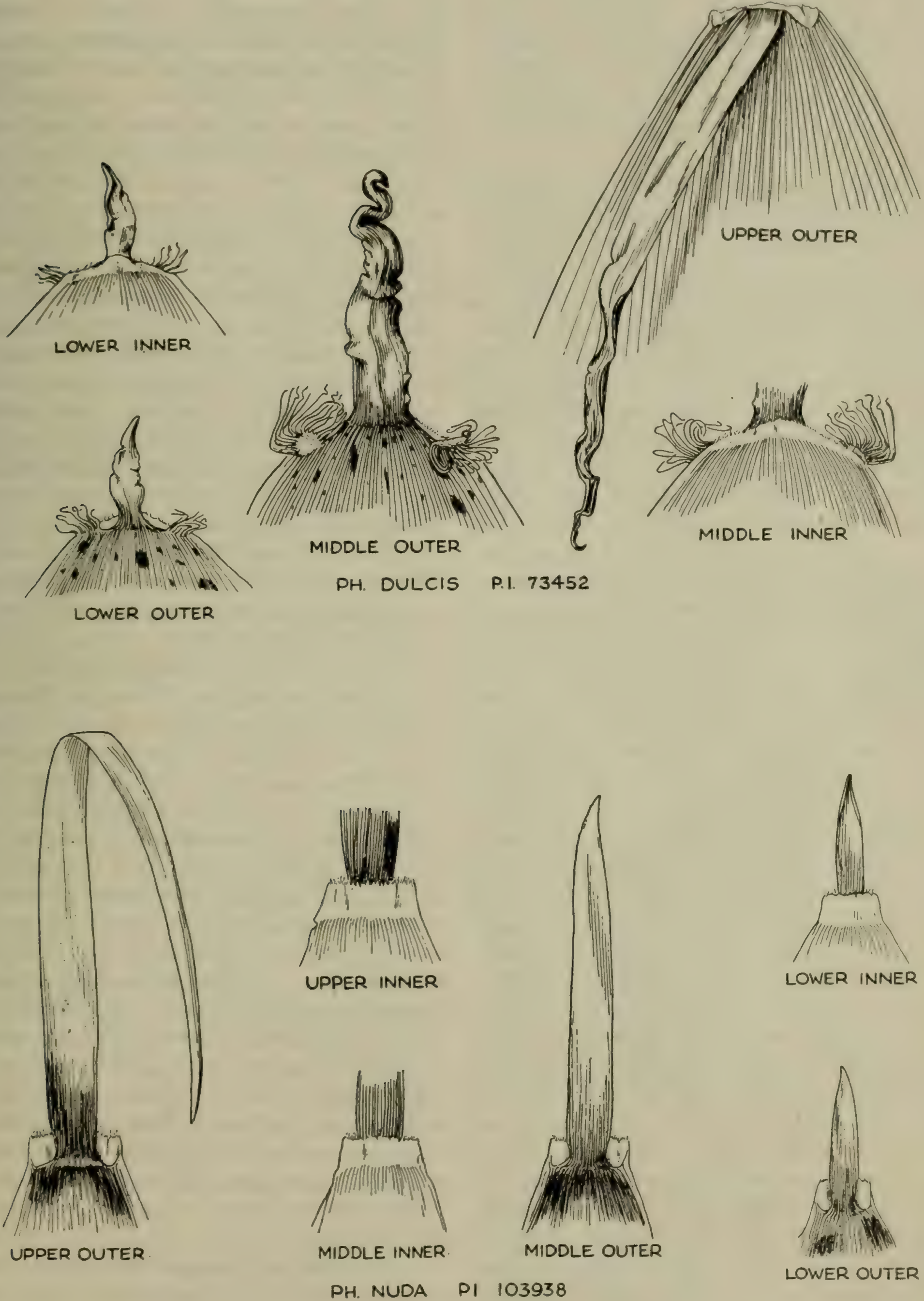

Fig. 2.—New species of *Phyllostachys*.

the relation of the auricles to the culm sheath blade, this species shows some resemblance to *Phyllostachys nidularia* Munro, from which it differs clearly, however, in the yellowish or greenish-golden sulcus of the internodes of the young culms and branches; the thinner, more flexible, entirely glabrous culm sheaths, the longer ligules of the culm sheath, the scabrousness of the internodes in young culms of mature stature, and the glabrous, less prominent culm sheath scars, and the less prominent culm nodes.

Culms up to 7.8 m tall and (int. V) 29 mm in diameter; *internodes* up to (no. XIII) 356 mm (V: 196 mm) long, in culms of mature stature more or less copiously farinose, retrorsely scabrous, and tinted or striped with yellow or greenish golden on the sulcus, especially in the first year; *nodes* glabrous, rather prominent but narrow; *farinose zone* usually extending both above and below the sheath scar; *culm sheath* oblong, rounded toward the apex, thin and flexible in texture, variable in color, always more or less conspicuously striped with white, yellow and (especially toward the base of the culm) wine and (especially toward the apex of the culm) green, and retaining, even in the dry state the variegation in the form of lighter and darker tints of straw, at first copiously and loosely (in plants of immature stature lightly) farinose, glabrous throughout, or the lower ones very rarely retrorse scabrous basally; *auricles* commonly not developed in the lowermost 4 or 5 sheaths, otherwise usually well developed, rarely all weak or lacking entirely, sometimes extremely variable in the same culm, commonly decurrent from the base of the blade, sometimes entirely distinct from the base of the blade, usually falcate or ovate, more or less excurrent, sometimes reflexed, when dry very thin and fragile and more or less crinkled; *oral setae* slender, flexuous, few to many, or (when the auricles are lacking) not at all developed, commonly crowded along the exterior (upper) margin of the auricles and fewer or none on the lower margin; *ligule* (in V) up to 3–4 mm long, progressively longer in the upper sheaths, subglabrous on the back, the apex strongly arched, the undulate margin ciliolate or fimbriate with coarse, scabrous processes; *sheath blade* erect or (in the lower sheaths) sometimes strongly reflexed, broadly to narrowly triangular, broadening abruptly at the very base, flat or sometimes revolute, not at all crinkled, obscurely scabrous on the adaxial surface, strongly so on the abaxial, both margins spinulose. *Branches* 3–5-foliate, glabrous throughout or the lower internodes more or less scabrous, sometimes somewhat farinose, the twigs commonly 1–2-leaved, glabrous throughout on culms of the current year, the uppermost internodes often puberulent in older culms. *Leaf sheaths* glabrous or rarely sparsely setose; *auricles* and *oral setae* extremely variable, weakly developed in few-leaved twigs, commonly more strongly developed in twigs and branches with more leaves; *ligule* up to 1.5 mm long, sparsely puberulent, the apex strongly arched, the uneven margin sparsely ciliolate; *petiole* glabrous or subglabrous on both surfaces; *leaf blades* up to 155 mm long and up to 19 mm broad, usually much shorter and narrower, glabrous on the upper surface, densely pilose or hirsute at the very base, sparsely pilose in the middle and scabrous toward the tip on the lower surface, the marginal spinules usually distant from each other and more or less spreading. *Inflorescence* unknown.

TYPE: McClure 20971, collected April 29, 1941, at the Barbour Lathrop Plant Introduction Garden near Savannah, Ga., from permanent plot no. 31 (section C).

This bamboo was originally introduced into the United States from China by Frank N. Meyer in 1908. It appears in the Plant Inventory of the Division of Plant Exploration and Introduction under P.I. 55713. It was carried for some years under the name of *Phyllostachys nevinii* Hance. Circumstantial evidence, however, led to the suspicion that this name was not properly applied to the present species. The type specimen of *P. nevinii*, which is deposited at Kew, was examined by the writer in 1935, and later by C. E. Hubbard, with a view to determining whether any close resemblance could be detected between it and the present plant. The concurrence of opinion is that the two represent entirely distinct species. Significant support is given to this view by the fact that this species has not come to light in, or anywhere near, the type locality of *P. nevinii* Hance, during the course of many years, diligent search.

An interesting characteristic of the species (at least of the plants grown in the United States)—one that detracts somewhat from the

value of many of the culms—is the rather frequent, but irregular, occurrence of one to several strongly geniculate nodes within the first meter from the ground. An experimental selection (P.I. 70741) was made by R. A. Young some years ago to ascertain if the occurrence of this character could be made more regular or more frequent by such selection, but no difference in its subsequent incidence has been noted.

The specific epithet alludes to the distinctive coloration of the sulcus of young culms and their branches.

Phyllostachys dulcis, sp. nov.

Species insignis culmis basin versus vulgo plus minusve curvatis, omnino glabris; internodiis copiose farinosis, tactu plus minusve valide striatis, interdum cum striis aureis linearibus obscure notatis; nodis infimis plerisque plus minusve valde gibbose incrassatis; vaginis culmi omnino glabris, fuscomaculatis, siccatate pallidissime stramineis; auriculis valde evolutis crassis, saepe plus minusve excurrentibus, novellis viridibus; lamina vaginarum culmi latiuscula, valde crispa. Species internodiis culmi glabris et plus minusve valde elevato-striatis *Phyllostachys vivacem* McClure simulans, e qua tamen differt habitu culmorum frondisque, auriculis vaginae culmi valde evolutis, vaginis culmi texturae tenuioris et (novellis) plus minusve colorato-striatis, et forma ligulae vaginarum culmi.

Culmi usque ad vel ultra 10 m alti et usque (int. V) ad 57×60 mm diametro, ab initio omnino glabri farinosique; *internodia* usque (no. XVIII) ad 255 mm (V: 210 mm) longa, tactu plus minusve valde striata et saepe striis tenuibus albidis vel pallido-luteis variegata, *ligno* 5–6 mm crasso; *nodi* prominuli, inferioribus saepe supra cicatricem gibbose incrassatis; *zona farinosa* angusta, capiose farinosa; *vaginae culmi* oblongae, versus apicem late rotundatae, texturae tenuis lentaeque, facile fissae, omnino glabrae, sparse floccoso-farinosae, novellis (in plantis staturae maturae) tum striis latiusculis albidis vel pallido-luteis variegatis et maculis fuscis sparsim maculatis, siccatis pallidissime stramineis maculatisque sed haud colorato striatis; *auriculae* ovatae vel angusto-oblongae excurrentes, crassae, dense pubescentes; *setae orales* valide evolutae, *auriculis* et *setis oralibus* primo viridibus deinde fusco-stramineis; *ligula* brevis, in vaginis superioribus vix vel paullum longior, dorso scabra, apice late arcuata, margine subtiliter ciliolata; *lamina vaginarum* anguste triangulata vel linearis, valde alveata crispaque, vulgo adscendens raro reflexa, superficie adaxiale basin versus hispidula, alioquin glabra vel subglabra. *Rami* comparate breves subaequales, glabri, primo plus minusve farinosi, ramis ramulisque plerisque 2–3-foliatis, ramis in surculis ex culmis decapitatis orientibus saepe 4–5-foliatis. *Vaginae foliorum* primo (dempto supremo valde pubescente) glabrae vel glabrescentes; *auriculae* et *setae orales* pervariabiles, saepissime haud evolutae, interdum (praesertim in surculis ex culmis decapitatis orientibus) valde evolutae; *ligula* valde exserta, mox fissa, dorso basin versus plus minusve hispidula, alioquin glabra, apice arcuata, margine undulata glabra vel subtiliter ciliolata; *petiolus* utrinque omnino glaber vel supra basin versus scaberulus; *laminae foliorum*, usque ad 100 mm longae et usque ad 16 mm latae, supra glabrae, subtus variabiliter pubescentes, vulgo saltem versus basin pilosae. *Inflorescentia* ignota.

Species distinguished by the following combination of characters: Culms commonly more or less strongly curved at the base, glabrous throughout; the internodes copiously farinose, more or less striate to the touch, often visibly striped with narrow cream or pale yellow lines, the lower nodes usually more or less strongly thickened asymmetrically, culm sheaths glabrous throughout, maculate with dark spots, very pale straw colored when dry, auricles thick, often more or less excurrent, green when fresh, culm sheath blade very strongly crisped. In its entirely glabrous culms, ribbed internodes, and asymmetrically thickened culm nodes, this bamboo somewhat resembles *Phyllostachys vivax* McClure but is readily distinguishable from the latter by the sparser maculation of the culm sheaths, the well-developed auricles and oral setae, the different shape of the culm sheath ligules, and the very pale straw color of the culm sheaths when dry.

Culms up to or exceeding 10 m tall and (int. V) up to 57×60 mm in diameter, glabrous and farinose throughout from the beginning; *internodes* up to (no. XVIII) 255 mm (V: 210 mm) long, more or less strongly ribbed (in the lower part of the culm at least) and very often verti-

cally striped with a few whitish or cream lines, the *wood* 5–6 mm thick; *nodes* somewhat prominent, the lower ones often asymmetrically thickened above the sheath scar; *farinose zone* relatively narrow, copiously farinose; *culm sheaths* oblong, rounded toward the apex, thin and tough, easily split, glabrous throughout, sparsely floccose-farinose, sparsely maculate (in plants of mature stature at least) with dark spots and (in fresh shoots) variegated with stripes of white or cream and, when dry, very pale straw in color with sparse persistent dark maculations but devoid of all color striation; *auricles* narrowly oblong, excurrent; *oral setae* well developed (the auricles and oral setae bright green when fresh, turning dark straw when dry); *ligule* short, scarcely or slightly longer in the upper sheaths, scabrous on the back, the apex arcuate, the undulate margin obscurely ciliolate; *sheath blade* narrowly triangular or linear, strongly alveate and crinkled, commonly ascending, rarely reflexed, hispidulous basally on the adaxial surface, otherwise glabrous or subglabrous. *Branches* relatively short, subequal, glabrous, at first more or less visibly farinose, branches and twigs usually 2–3-foliate, branches from shoots originating at the base of decapitated culms often 4–5-foliate. *Leaf sheaths* at first glabrous or glabrescent, excepting the uppermost persistently pubescent one; *auricles* and *oral setae* quite variable, often not at all developed, sometimes (particularly in shoots from decapitated culms) strongly developed; *ligule* strongly exserted, soon split, more or less hispidulous toward the base, otherwise glabrous, the apex convex, the undulate margin glabrous or obscurely ciliolate; *petiole* entirely glabrous on both sides or scaberulous basally on the upper surface; *leaf blades* up to 100 mm long and up to 16 mm broad, mostly much shorter and narrower, glabrous on the upper surface, of variable vesture on the lower surface, commonly pilose toward the base at least. *Inflorescence* unknown.)

TYPE: McClure 20974, collected April 29, 1941, at the Barbour Lathrop Plant Introduction Garden near Savannah, Ga., from permanent plot no. 70 (section C).

This bamboo appears in the Plant Inventory of the Division of Plant Exploration and Introduction under P.I. 73452, where it is described as "the edible bamboo of central China." The material under this number was presented to the U. S. Department of Agriculture in April 1927 by E. A. McIlhenny from plants cultivated in the bamboo garden at Avery Island, La. It represents one of the introductions of Frank N. Meyer that Mr. McIlhenny had received from the Department some years earlier.

The culms of this species, being generally rather strongly curved, with prominent, often asymmetrical thickened nodes, and culm walls of uneven thickness, are of little industrial promise. The shoots, however, have been pronounced, by both Dr. David Fairchild and Mr. McIlhenny, as the best-flavored of any of the kinds that they have tested. Concerning this species, Mr. McIlhenny says it is, in his opinion, the most rapid-growing and most prolific of the bamboos in his garden.

This species has been carried in the records of the Division of Plant Exploration and Introduction for many years under the name *Phyllostachys henryi* Rendle. There is no discernible basis for this identification, however, and it seems desirable to give the plant a clearly documented scientific name based on the vegetative characters by which it is so well distinguished. *P. henryi* Rendle was based on flowering material only, collected by A. Henry (no. 6338) at Nanto, Hupeh. The leaf sheath is described as having a *short, truncate* ligule, a character clearly shown by the type. The leaf sheath in our plant has a *long-exserted* ligule with a *rounded* apex. In view of the very slight variability in the shape and dimensions of this structure in the 20-odd other species of the genus, living plants of which have been carefully studied, it is considered sufficient to separate the two plants in question.

The specific epithet alludes to the superior palatability of the young shoots.

Phyllostachys meyeri, sp. nov.

Species insignis culmis (demptis cicatricibus puberulis, vaginarum) glabris, modice farinosis, vaginis culmi ima basi in zona angustissima puberulis, alioquin glabris, auriculis et setis oralibus in vaginis culmi haud evolutis, ligula longitudinis mediocris, apice late arcuata, margine haud crasse fimbriata, lamina lineari, plana vulgo haud vel vix crispa. Species simulans *Ph. auream* (Carr.) Riv. sed in notis sequentibus distinguenda: internodiis culmi abnomiter abbreviatis nullis; ligulis vaginarum

infimarum culmi longioribus et angustioribus; ligulis vaginarum superiorum culmi cum fimbriis marginalibus haud valde evolutis; ligula vaginarum foliorum valde exserta.

Culmi usque ad 9.4 m alti et usque (int. V) 45×47 mm diametro; *internodia* usque (no. XIX) ad 352 mm (V: 185 mm) longo, moderate farinosa, omnino glabra, *ligno* (int. V) 6–6.5 mm crasso; *nodi* prominuli, latiusculi, cicatrice primo pilis pallidis confertis in zona angustissima circumdata, mox glabrescente; *zona farinosa* angusta lente accrescens mox sordescens; *vaginae culmi* oblongae apice rotundatae, omnino glabrae vel raro marginibus sparsissime ciliatae, vix farinosae sed tactu ceratae, pleraque praecipue apicem versus cum maculis fuscis maculatae, in statu siccato lentae, subrigide coriaceae cum nervis crassis moderate prominentibus; *auriculae* et *setae orales* haud evolutae vel in culmis humilibus raro modice evolutae; *ligula* comparate brevis, haud valde exserta, dense hispidula, apice late arcuata, margine obscure ciliolata; *lamina* linearis vel sublinearis haud vel vix ad basin angustata, in vaginis inferioribus alveata, interdum plus minusve crispa, erecta, in vaginis saltem superioribus plana et plus minusve recurvata, utrinque obscure scabra, secus margines scabra. *Rami* 3–5-foliati, ramulis 2–3-foliatis, omnibus in internodiis superioribus secus sulcum pilis retrorse uncinatis dense pubescentibus alioquin omnino glabris, eorum vaginis glabris. *Vaginae foliorum* vestitu pervariabiles—in plantis humilis vulgo plus minusve pubescentes, sed in plantis staturae maturae saepissime omnino glabrae vel pro parte tantum sparse pubescentes; *auriculae* et *setae orales* in plantis humilibus valde evolutae sed in plantis staturae maturae haud vel vix evolutae; *ligula* valde exserta, fragilissima saepissime fissa, ima basi hispidula alioquin glabra, apice valde convexa, margine glabra vel sparsissime ciliolata; *petiolus* supra ima basi tantum pubescens, alioquin omnino glaber in plantis staturae maturae, sed in plantis humilibus utrinque praesertim in superficie inferiore dense pubescens; *laminae foliorum* lanceolatae vel oblongo-lanceolatae, usque ad 162 mm longae et 29 mm latae, supra glabrae, subtus ima basi dense pilosa apicem versus vel pilosae vel scabrae. *Inflorescentia* ignota.

Species distinct in the following combination of characters: Culms glabrous except the sheath scars, moderately farinose, the culm sheaths with a very narrow puberulent band along the lower margin, otherwise entirely glabrous, lacking auricles and oral setae, the ligule of moderate length, the apex broadly arched, the margin not coarsely fimbriate, the sheath blade narrow, linear, usually not at all crinkled. Species closely resembling *Phyllostachys aurea* (Carr.) Riv. in superficial appearance but differing in the following characters: the complete lack of abnormally shortened internodes appearing so commonly in the culms of the latter species; the (vertically) longer and (transversely) narrower ligules of the lower culm sheaths; the not at all prominently fimbriate ligules of the upper culm sheaths; the strongly exserted ligule of the leaf sheaths.

Culms up to 9.4 m tall and (int. V) 45×47 mm in diameter; *internodes* up to (no. XIX) 352 mm (V: 185 mm) long, the surface moderately farinose, entirely glabrous, the *wood* (int. V) 6–6.5 mm thick; *nodes* only moderately prominent, rather broad, the sheath scar fringed at first with a dense, narrow band of very short, pale hairs, soon glabrescent, the *farinose zone* narrow, developing slowly and soon becoming gray to black; *culm sheaths* oblong, rather abruptly rounded at the apex, entirely glabrous or rarely with a few cilia along the margins, not noticeably farinose, but somewhat waxy to the touch, mostly somewhat maculate with smallish, smoky spots, especially toward the apex, tough, stiffly leathery, and with the coarse veins only moderately salient, when dry; *auricles* and *oral setae* not at all developed except rarely in very small culms where, in the upper sheaths a few slightly developed ones may occasionally be found; *ligule* relatively short, only slightly wider than the base of the sheath blade, not conspicuously exserted, only slightly longer in the upper sheaths than in the lower, hispidulous on the back, the apex usually broadly arcuate, the margin slightly undulate, obscurely ciliolate; *sheath blade* sublinear to linear, erect or, in the upper part of the culm more or less drooping, alveate and often more or less crinkled in sheaths from the lower part of the culm when dry, flat in the upper ones, obscurely scabrous on both margins and on both surfaces, more strongly so toward the apex; *branches* 3-foliate, twigs 2–3 leaved, puberulent with minute retrorsely hooked hairs along the sulcus of the

uppermost internodes, otherwise glabrous throughout, the branch sheaths glabrous; *leaf sheaths* of variable vesture, in small plants typically more or less densely pubescent, in large plants often glabrous or sparsely pubescent in part only; *auricles* and *oral setae* apparently developed in inverse proportion to the size of the plant—well developed in small plants and not at all or only weakly so in large ones; *ligule* prominently exserted, delicate and very frequently split longitudinally, hispidulous basally, otherwise glabrous, the apex strongly convex, the margin glabrous or sparsely ciliolate; *petiole* puberulent at the base on the upper surface, otherwise glabrous throughout in all leaves on large plants, but pubescent on both surfaces (more densely so on the lower surface) in small plants; *leaf blades* up to 162 mm long and up to 29 mm broad, always glabrous on the upper surface, densely pilose basally and decreasingly so toward the apex on the lower surface, more densely so in small, young plants, more weakly so in the first leaves of large plants. *Inflorescence* unknown.

TYPE: McClure 20984, collected April 29, 1941, at the Barbour Lathrop Plant Introduction Garden, near Savannah, Ga., from permanent plot no. 32 (section C).

This bamboo was introduced into the United States from China by Frank N. Meyer. It appears in the Plant Inventory of the Division of Plant Exploration and Introduction under P.I. 116768. The original records pertaining to this bamboo apparently were confused in the beginning with those belonging to other introductions, so that it is not possible to give any information as to the precise origin of this bamboo or the part it plays in the local Chinese economy. Some propagating material of this species has been distributed in this country. A thriving colony an acre or more in extent is to be found on the experimental farm of the Florida State Agricultural College at Gainesville, Fla.

Phyllostachys nuda, sp. nov.

Species insignis culmis glabris, tactu striatis, plus minusve copiose farinosis; vaginis culmi laxe farinosis, vulgo tactu glabris vel plerisque (pro parte saltem) inter nervos valde prominentes vel scabris vel cum unguellis antrorsis munitis, manifeste fusco-maculatis, siccatate conferte et crasse nervosis, fusco-stramineis; auriculis et setis oralibus haud evolutis, ligula valde exserta, apice truncata margine plus minus valde ciliolata, lamina vaginae lanceolato-lineari, plus minus patente, plerumque haud valde reflexa, auriculis et setis oralibus in vaginis foliorum haud evolutis. Species valde simulans *Phyllostachys flexuosam* Riv. sed distinguenda vaginis culmae inter nervos prominentes scabris, vaginis foliorum sine auriculis et setis oralibus. Species valde affinis *Phyllostachys arcanae* McClure sed conformatione apicis ligulae sat distincta.

Culmi usque ad 5.5 m alti et (int. V) 30 mm diametro, omnino glabri; *internodia* primo (praecipue sub nodis) plus minusve copiose farinosa, tactu striata, usque (no. XIV) 310 mm (V: 170 mm) longo, ligno 4 mm crasso; *nodi* prominuli; *vagina* oblonga, apice versus leniter angustata, saltem infimis fusco-maculatis, tactu raro omnino glabra sed vulgo (saltem in parte superiore) inter nervos valde prominentes cum unguellis antrorsis aspera, in statu siccato subcoriacea fissilis; *auriculae* et *setae orales* haud evolutae; *ligula* longe exserta, dorso scabra, apice truncata, margine ciliata; *lamina* fere erecta, rare valde reflexa, infimis lanceolatis alveatis plus minusve undulantibus, superioribus lineari-lanceolatis planiusculis, omnibus utrinque et in marginibus antrorse scabris. *Rami* glabri, 3–4-foliati, ramulis vulgo 2-foliatis. *Vaginae foliorum* glabrae vel suprema setis retrorsis setulosae-*auriculae* et *setae orales* haud evolutae; *ligula* longe exserta, dorso scabra, apice convexa, margine primo ciliolata demum sensim diffracta; *petiolus* subtus glaber, supra versus basin hispidulus; *laminae foliorum* lanceolatae vel lineari-lanceolatae, usque ad 150 mm longae et 22 mm latae, supra glabrae et nitidae, secus marginem alteram omnino glabrae, secus alteram scabrae. *Inflorescentia* ignota.

Species distinguished by the following combination of characters: Culms glabrous, striate to the touch, more or less copiously farinose; culm sheaths loosely farinose, sometimes glabrous to the touch but usually provided, in part at least, with minute antrorse hooks secluded between the coarse veins; irregularly maculate or stained with dark spots, dark straw in color and densely and coarsely nervose when dry; the auricles and oral setae not developed; the ligule strongly exserted, truncate at the apex, ciliate along the margin; sheath blades lanceolate-linear, more or less spreading, usually not strongly reflexed; auricles and oral

setae not developed in leaf sheaths. Species strongly resembling *Phyllostachys flexuosa* Riv. from which it is readily distinguished by the scabrousness between the veins of the culm sheaths, and the complete lack of auricles and oral setae in the leaf sheaths. Closely related to *Phyllostachys arcana* McClure, from which it may be readily distinguished by the truncate ligule of its culm sheath.

Culms up to 5.5 m tall and (int. V) 30 mm in diameter, entirely glabrous; *internodes* more or less copiously farinose at first, especially immediately below the nodes, the surface perceptibly ribbed, entirely glabrous, up to (no. XIV) 320 mm (V: 170 mm) long, the *wood* about 4 mm thick; *nodes* rather prominent; *culm sheath* oblong, gently narrowed toward the apex, the lower ones, especially, usually more or less conspicuously marked by diffuse purplish splotches of variable size and intensity of color, often copiously and loosely farinose at first, sometimes entirely smooth to the touch or, more commonly, perceptibly scabrous with antrorse prickles disposed in variable density between the veins, especially in the upper part, tough and husk-like, though easily split, when dry, the veins then very prominent and close together; *auricles* and *oral setae* not at all developed; *ligule* prominently exserted, scabrous on the back, the apex truncate, the margin irregular and ciliate; *sheath blade* usually erect or strongly ascending, rarely more or less strongly reflexed in the lower sheaths, lanceolate, alveate and more or less perceptibly crinkled in the lower sheaths, to linear, lanceolate and flat or nearly so in the upper ones, obscurely antrorse-scabrous on both surfaces and on both margins. *Branches* entirely glabrous, usually 3–4-foliate, the twigs commonly 2-foliate. *Leaf sheaths* glabrous or the uppermost sometimes setulose with retrorse hairs; *auricles* and *oral setae* not developed; *ligule* in the lower sheath rather prominently exserted (that in the upper sheath obscure), scabrous on the back, the apex strongly convex, the margin minutely ciliolate at first, fragile, soon becoming more or less broken; *petiole* glabrous on the lower surface, hispidulous basally on the upper surface; *blades* up to 150 mm long and 22 mm broad, glabrous and shining on the upper surface, paler and antrorsely scabrous throughout the lower surface and sparsely hirsute basally with pale antrorse hairs, glabrous from base to tip on one margin, scabrous on the other. *Inflorescence* unknown.

Type: McClure 20992, collected May 19, 1941, at the old Van Fleet residence, later the residence of P. H. Dorsett, near Glenn Dale, Md.

According to the records, this bamboo was originally introduced into this country from China by Frank N. Meyer. It appears in the Plant Inventory of the Division of Plant Exploration and Introduction under P.I. 103938, which represents material secured by the Department of Agriculture from Mr. Dorsett's place.

A large and flourishing colony of this bamboo is under cultivation in the garden of the residence of Dr. George M. Darrow, near the Plant Introduction Garden at Bell, Md. The culms have been variously employed by Dr. Darrow about the premises for temporary structures such as arbors, trellises, fences, garden stakes, etc., while the shoots harvested to hold the colony in check find a welcome place in the family menu. From personal experience I know that the shoots of this bamboo, when small (4 to 6 inches long) are very palatable, among the best I ever ate. This species appears to be very hardy at this latitude, having been seriously injured by cold only a few times during the last fifteen years at the Darrow place. It deserves to be more widely cultivated as a source of poles and shoots for home use.

The specific epithet alludes to the absence of auricles and oral setae in both the culm sheaths and the leaf sheaths.

Phyllostachys propinqua, sp. nov.

Species insignis culmis omnino glabris ad primo (dempto zona angusta infra nodos) fere haud farinosis, vaginis culmi omnino glabris cum lamina anguste lineari, auriculis et setis oralibus vaginis culmi haud evolutis, ligula vaginarum culmi in apice valde arcuata, in margine haud crasse fimbriata insignis. Species praesertim quoad surculos novellos arcte simulans *Phyllostachys meyeri* McClure sed in notis saltem sequentibus distinguenda: cicatricibus in nodis culmorum glabris; lamina vaginarum culmi angustiore brevioreque; ligula praecipue in vaginis superioribus culmi valde arcuata; foliorum laminis plerumque (dempto basi hirsuto) subtus glabris.

Culmi usque ad 7 m alti et (int. V) 30×31 mm diametro, omnino glabri; *internodia* primo fere haud farinosa, usque (no. XI) ad 258 mm

(V: 171 mm) longa, *ligno* (int. V) circ. 5 mm crasso; *nodi* in cicatrice modice prominentes; *zona farinosa* angusta sed cicatricem superante, primo exiguua deinde sensim valida; *vaginae culmi* anguste oblongae vel lineares, apice leniter rotundatae, omnino glabrae, haud vel subtilissime farinosae, in siccitate tenuiter subcoriaceae, plus minusve valde nervosae; *auriculae* et *setae orales* haud evolutae; *ligula* dorso obscure scabra, apice plus minusve valde arcuata, margine minute ciliolata; *lamina* patens (infimis reflexis), angusta, linearis, haud vel vix crispa, in superficie adaxiali scabriuscula, in abaxiali subglabra, siccata plus minusve valde alveata. *Rami* 3–5-foliati, eis et vaginis suis glabris, ramulis plerisque 3–4-foliatis. *Vaginae foliorum* glabrae; *auriculae* et *setae orales* pervariabiles, interdum haud evolutae, interdum nonnullae modice evolutae, interdum etiam praecipue in culmis vel humilibus juvenilibus vel depauperatis vel senescentibus valde evolutae; *ligula* valde exserta, dorso hispidula, apice arcuata, margine undulante subtiliter ciliolata; *petiolus* vulgo supra basin versus hispidulus, alioquin glaber; *lamina* vulgo usque ad 135 mm longa et usque ad 16 mm lata, subtus semper basin versus secus costam hirsuta, interdum in partibus vicinis pilosa, secus alteram marginem spinosula, alteram glabra. *Inflorescentia* ignota.

Species distinct in this combination of characters: Culms glabrous throughout and (excepting the narrow zone just below the nodes) almost not at all farinose, the culm sheaths glabrous and without auricles and oral setae, the ligule strongly arched, especially in the upper sheaths, and not coarsely fimbriate, the sheath blade very narrow and not or scarcely crinkled. This bamboo is very similar to *Phyllostachys meyeri* McClure in general appearance—especially that of the young shoots—but is distinct in at least the following characters: the glabrousness of the culm sheath scar, the narrower culm sheath blades, the strongly convex apex of the ligule of the culm sheath, the leaf blades normally not pubescent on the lower surface except along the midrib at the base. A further difference, hardly to be designated as more than a tendency, is the frequent occurrence, in *P. propinqua*, of culms with two or three more or less strongly geniculate nodes, usually within less than a meter of the base. In addition to the strong general resemblance of the two species in their "normal" expression, they have in common this expression which, under the circumstances described tends to obliterate differences normally shown in the pubescence of the leaf blades: In low, shrubby growth originating from decapitated or otherwise thwarted or stunted culms of both species, the leaf sheaths, petioles and lower surface of the leaf blades are densely pubescent, and the upper surface of the leaf blades is strongly scabrous throughout. Furthermore, in such plants there are often more leaves per twig than in the larger ones, and both the auricles and oral setae are more prominently developed on the leaf sheaths thereof.

Culms up to 7 m tall and (int. V) 30×31 mm in diameter, glabrous throughout; *internodes* up to (no. XI) 258 mm (V: 161 mm) long, the farinose zone rather narrow but extending slightly above the sheath scar, thin and indistinct at first, then gradually becoming distinct and more densely farinose (*branch buds* lacking at nodes 1–11 in the largest culm measured, the lower several in the series sometimes remaining undeveloped, but viable, for more than a year, an occurrence very rare in the genus); *culm sheaths* narrowly oblong or linear, gently rounded above to a narrow apex, entirely glabrous throughout, more or less prominently ribbed, tough and thinly coriaceous when dry (the basal ones distinctly thicker and stiffer, with less prominent nerves than the upper ones), lightly and irregularly maculate with small dark spots; *auricles* and *oral setae* not at all developed; *ligule* obscurely scabrous on the back, the apex more or less strongly convex, the margin minutely ciliolate; *sheath blade* very narrow, linear, often more or less perceptibly crinkled, slightly scabrous on the adaxial surface, subglabrous on the abaxial, those on the lower sheaths reflexed, those on the upper ones recurved, and flat or nearly so, all becoming more or less strongly alveate upon drying. *Branches* 3–5-foliate. *Leaf sheath* glabrous; *auricles* and *oral setae* of variable occurrence and development, sometimes lacking entirely, sometimes moderately well developed and sometimes, especially in the leaf sheaths of low shrubby growth originating from decapitated or otherwise thwarted or stunted culms, or from old culms, the auricles and oral setae very strongly developed; *ligule* strongly exserted, hispidulous on the back, the apex

strongly arched, the margin irregular, minutely ciliolate; *petiole* usually hispidulous basally on the upper surface, otherwise glabrous; *leaf blades* commonly up to 135 mm long and up to 16 mm broad, always hirsute along the midrib basally on the lower surface, and often more or less pilose nearby, otherwise glabrous throughout. *Inflorescence* unknown.

Type: McClure 20976, collected April 29, 1941, at the Barbour Lathrop Plant Introduction Garden, near Savannah, Ga., from permanent plot no. 10 (section C).

This bamboo was introduced into the United States from China by the writer in 1926. It appears in the Plant Inventory of the Division of Plant Exploration and Introduction under

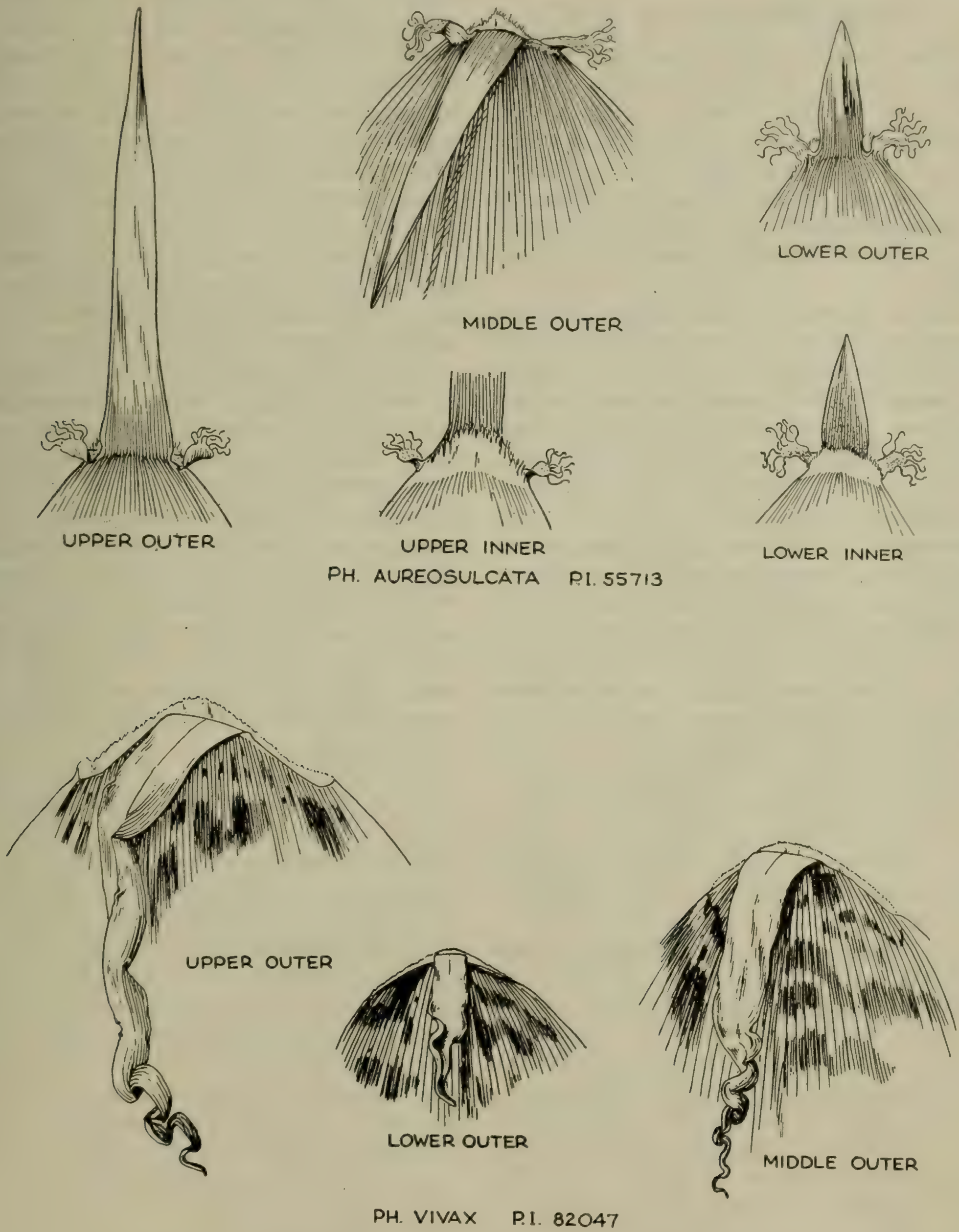

Fig. 3.—New species of *Phyllostachys*.

P.I. 76649. In the notes given there, the comparison between this species and P.I. 67398 (*Phyllostachys rubromarginata* McClure) quoted from a Chinese informant, does not apply, as the culm sheaths of both species are entirely glabrous.

The specific epithet alludes to the close resemblance between this species and *P. meyeri*.

Phyllostachys vivax, sp. nov.

Species aspectu nobilis frondibus elegantibus subpendulis, culmis altis omnino glabris, internodiis copiose farinosis, tactu striatis, vaginis culmi omnino glabris fusco-maculatisque, ligula vaginarum culmi perbrevi, valde arcuata, latissima, longe utrinsecus decurrente, auriculis et setis oralibus (vaginarum culmi staturae maturae) haud evolutis insignis.

Species internodiis culmi glabris et tactu striatis, nodis saepe gibbose incrassatis simulans *Phyllostachys dulcem* McClure sed auriculis in vaginis culmi (plantae staturae maturae) numquam evolutis, earumdem ligula perbrevi utrinsecus longe decurrente distinguenda. Species notis nonnullis vaginae culmi simulans *Phyllostachys sulphureae* var. *viridem* Young et praeterea *P. bambusoides* Sieb. & Zucc. ex quibus distat characteribus saltem sequentibus inter alias: internodiis culmi tactu valde striatis, nodis plerisque supra cicatricem gibbose incrassatis, vaginis culmi tenuioribus, ligula perbrevi, praesertim in vaginis inferioribus utrinsecus longe decurrente, habitu subpendula laminarum foliorum.

Culmi usque ad 11.8 m alti et (int. V) 70×75 mm diametro, omnino glabri; *internodia* usque (no. XIX) ad 327 mm (V: 243 mm) longa, tactu striata, ab initio copiose farinosa, supra nodos saepissime plus minusve gibbose incrassata, *ligno* 7–8 mm crasso; *nodi* in cicatrice crassa subito prominentes et supra cicatricem aperte incrassati; *zona farinosa* latiuscula copiose farinosa; *culmi vaginae* oblongae versus apicem convexum rotundatae, dorso marginibusque omnino glabrae, ab initio farinosae, maculis fuscis conferte maculatae, siccatae crasse nervosae, tenuiter coriaceae; *auriculae* et *setae orales* (demptis plantis juvenilibus) numquam evolutae; *ligula* perbrevis valde arcuata, utrinsecus longe decurrens, dorso subglabra, margine ciliolata vel subglabra. *Lamina vaginarum* anguste triangulata vel sublinearis, valde alveata cristaque, erecta vel reflexa, utrinsecus subglabra. *Rami* comparate breves, internodiis glaucis vel supremis in sulco puberulis deinde sensim glabrescentibus, ramis ramulisque plerisque 2–4-foliatis. *Foliorum vaginae* dorso glabrae marginibus ciliolatae; *auriculae* in vaginis supremis saepe haud evolutae, alioquin debiliter vel modice evolutae, ovatae, fragiles vulgo sensim fugantes; *setae orales* saepe mox fugantes, in vaginis superioribus saepe paucae adpressaeque, in inferioribus plures radiataeque; *ligula* brevis, dorso subtiliter scabra, apice arcuata mox fissa, margine undulata subtiliter ciliolata; *petiolus* supra basin versus vulgo puberulus vel scaber, subtus apicem versus interdum pilosus, alioquin utrinque glaber; *foliorum laminae* usque ad 175 mm longae et usque ad 25 mm latae, supra glabrae nitidaeque, basin versus secus costam pilosae, alioquin subtilissime scabrae. *Inflorescentia* ignota.

Species of striking appearance with elegant subpendent foliage, readily distinguishable from the other species by the following characters: The glabrous culms, with copiously farinose, rather prominently ribbed or striate internodes, the culm sheaths thinnish, glabrous, densely maculate with smoky spots, the ligule of the culm sheath very short, strongly arcuate, long decurrent on each side of the apex of the sheath especially in the lower sheaths, the sheath blade narrow and very much crinkled, the auricles and oral setae never developed in the sheaths of culms of mature stature.

This species is perhaps at first sight most likely to be confused with *Phyllostachys sulphurea* var. *viridis* Young, or *P. bambusoides* Sieb. & Zucc. From both of these, however, it may readily be distinguished by the striate internodes and peculiarly shaped nodes of the culms, the entire lack of any vestige of auricles on the culm sheaths (at least in plants of mature stature) and the very short, decurrent culm sheath ligule. Once familiar, the habit of the foliage is sufficient to distinguish this species from the others even at a distance. In the ribbed surface and glaucousness of the internodes and the complete glabrousness of the culms, mature plants of this species resemble those of *P. dulcis* McClure, but the latter is distinguishable by the well developed green auricles and oral setae on its more or less

conspicuously color-striate fresh culm sheaths, and the less decurrent ligule of the lower culm sheaths.

Culms up to 11.8 m tall and (int. V) 70×75 mm in diameter; *internodes* up to (no. XIX) 327 mm (V: 243 mm) long, strongly striate to the touch, glabrous throughout, copiously farinose from the first, the part above the node commonly perceptibly larger in diameter than the part below the node and somewhat gibbous, the *wood* 7–8 mm thick; *nodes* flaring rather abruptly at the sheath scar and thickened somewhat asymmetrically above it; *farinose zone* broadish, copiously farinose; *culm sheaths* entirely glabrous, farinose, densely maculate with dark spots, coarsely nervose and thinly coriaceous when dry; *auricles* and *oral setae* lacking entirely in plants of mature stature (more or less well developed in small plants); *ligule* short, subglabrous, the apex strongly arcuate, the margin ciliolate or subglabrous; *sheath blade* narrowly, triangular to sublinear, strongly crinkled, erect or reflexed, subglabrous on both surfaces. *Branches* relatively short, glaucous, glabrous or several of the uppermost internodes pubescent at first then glabrescent, the branches and twigs 2–4-foliate. *Leaf sheaths* glabrous, the margins ciliolate; *auricles* sometimes slightly to moderately developed, ovate, all fragile and gradually disappearing; *oral setae* fragile, fugaceous, few and appressed in the upper sheaths, more numerous and radiate in the lower sheaths; *ligule* short, usually splitting in the middle, dorsally obscurely scabrous, the apex arcuate, often more or less concave in the middle, the undulate margin obscurely ciliolate; *petiole* commonly puberulent at the base on the upper surface and often pilose toward the base of the leaf blade on the lower surface, otherwise glabrous on both surfaces; *leaf blades* up to 175 mm long and up to 25 mm broad, glabrous and shining above, the lower surface usually somewhat pilose along the midrib at the base, otherwise obscurely scabrous. *Inflorescence* unknown.

TYPE: McClure 21044, collected May-August 1942, at the Barbour Lathrop Plant Introduction Garden near Savannah, Ga., from permanent plot no. 72 (section C).

This is one of Frank N. Meyer's introductions from China, but its precise origin is unknown. It appears in the Plant Inventory of the Division of Plant Exploration and Introduction under P.I. 82047, where the following information is given: "This bamboo, according to a statement of Nov. 19, 1929, from Mr. E. A. McIlhenny, is one of two introductions sent to him from Chico, Calif., by the Department of Agriculture, April 3, 1914, under nos. 23242 and 23243."

Although he was at first of the opinion that it represented *Phyllostachys mitis* of authors (*P. sulphurea* var. *viridis* Young) the plant was later recognized by Mr. McIlhenny, in the course of his long experience in its cultivation, as distinct from that and all the other bamboos in his collection.

The writer, upon seeing only smallish culm shoots of the plant for the first time in 1935 took them to represent *P. bambusoides* or something very near to it. Mr. McIlhenny rightly disagreed firmly, and later communicated his reasons for his view. The relevant statements in a letter of June 4, 1941, from Mr. McIlhenny to Mr. R. A. Young, may be paraphrased as follows:

"The new growth of P.I. 82047 averages ten days or two weeks earlier than that of *P. bambusoides*. The plant is much more vigorous, reaches maturity much more quickly, and the culms have much thinner walls than those of *P. bambusoides*. The lower internodes of this plant are longer than those in *P. bambusoides*, and the sheath blade is not fluted or crinkled in the same manner as in *P. bambusoides*. The culms reach a much greater size in the same period of time when planted side by side with *P. bambusoides*. When the two were planted side by side P.I. 82047 completely shaded and killed the growth of *P. bambusoides*. I believe P.I. 82047 is distinct from *P. bambusoides* and much more valuable for culture in the United States."

The specific epithet alludes to the vigorous vegetative growth so vividly described by Mr. McIlhenny.

ZOOLOGY.—*Two new lungworms,* Protostrongylus gracilis *and* Varestrongylus sinicus *(Nematoda: Protostrongylinae), from sheep and goats in China.*[1]

G. DIKMANS, U. S. Bureau of Animal Industry.

The nematodes described below were collected from sheep in China and sent to the United States by Drs. P. L. Li and F. J. Kwong, of the Northwest Epidemic Prevention Bureau, Lanchow, China. They were submitted to the Zoological Laboratory of the National Institute of Health. Dr. E. B. Cram, of that laboratory, subsequently referred them to the Zoological Division of the Bureau of Animal Industry.

Protostrongylus gracilis, n. sp.

Description.—Male (one entire specimen available) 8.5 mm long and 0.065 to 0.07 mm wide in region immediately anterior to bursa. Bursal rays arranged in pattern characteristic of the genus, namely, ventral rays originating from a common stem, separated in their distal portions, ventroventral somewhat shorter than lateroventral. Anterolateral or externolateral ray, shortest of the bursal rays, separated from both ventral and other lateral rays. Mediolateral and posterolateral rays close together, the former reaching the margin of the bursa. Externodorsal separate. Dorsal ray short, rounded, apparently provided with small papillae on the ventral surface as in other members of the genus. It is, however, impossible to determine their size and location in the material available for study. The usual chitinous arc and telamon are present. Spicules 0.325 mm long. Gubernaculum[2] consists of the usual three parts, capitulum, corpus and crura, or head, body, and legs. Capitulum or head is a light refracting, colorless body, consisting of three parts, two boat-shaped structures with keels directed dorsolaterally and a third part ventral to them with arms extended at right angles. Corpus or body supported distally by two laterally placed, sclerotized rods extending anteriorly from the crura or legs for a distance of 0.050 mm. Remainder of corpus is, like the head or capitulum, colorless. Crura or legs 0.030 to 0.035 mm long, moderately sclerotized, light brown; they are slightly curved ventrally in their distal portions and end in more or less blunt points.

Female.—Length unknown (no entire specimens being available for study), width about 0.040 mm. Vagina about 0.450 mm long. Vulva located on rather prominent protruberance about 0.150 mm from tip of tail. Anus 0.050 mm from tail end. Tail bluntly rounded. Eggs in utero 0.090 mm long by 0.035 to 0.040 mm wide. Provagina absent.

Hosts.—Sender (Dr. P. L. Li) reports nematode commonly present in sheep and goats in Lanchow, China. Specific identity of sheep and goats not stated.

Location.—Terminal bronchioles and lung tissue.

Distribution.—Lanchow, China.

Specimens.—U.S.N.M. Helm. Coll. No. 45104.

Remarks.—*Protostrongylus gracilis* resembles *P. skrjabini* as described by Boev (1937), but that author presented no figures with his description. It is, therefore, impossible, at the present time, to compare the two nematodes, especially with reference to those structures upon which species differentiation in the genus is based.

Varestrongylus sinicus, n. sp.

Description.—*Male* 12 to 15 mm long and 0.150 mm wide in region anterior to bursa. Tail sharply bent and rigidly supported so that it is almost impossible to flatten out the posterior part of the body in the ventrodorsal position. The ventral parts of both lobes of the bursa are folded inward so that the course and disposition of the terminal portions of the ventral rays are difficult to follow. The arrangement of the bursal rays is similar to that of other members of the subfamily Protostrongylinae. The ventral rays arise from a common stem and are separated only in their distal portions. The ventroventral ray is much larger and longer than the ventrolateral. It follows the fold of the bursal lobe and reaches the margin of the bursa. At its termination there is a slight indentation or notch in the bursal margin. The ventrolateral ray is comparatively small. The anterolateral or externolateral ray is, as

[1] Received June 1, 1945.

[2] For the purpose of describing this structure, the terminology of Schulz, Orlow, and Kutass (Zool. Anz. **102**(11/12). 1933) has been adopted.

in other members of this group of nematodes, rather widely separated from both the ventral rays and from the other lateral rays. The mediolateral and externodorsal rays present no distinctive features, but the posterolateral is very small. The morphology of the dorsal ray, especially its termination, is difficult to determine because of its position in the sharply bent, rigid posterior end of the body. It has a fairly long stalk and appears to terminate in two or perhaps three processes. Spicules 0.350 mm long provided with the usual sclerotized combs or rods beginning about 0.2 mm from

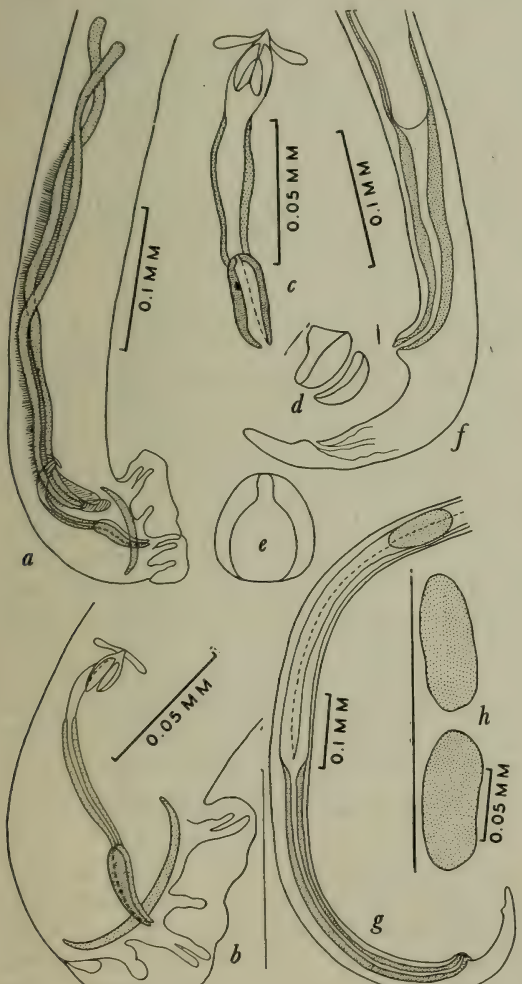

FIG. 1.—*Protostrongylus gracilis*, n. sp.: *a*, Posterior end of male, showing spicules; *b*, posterior end of male, showing gubernaculum and bursal rays; *c*, gubernaculum; *d*, parts of head of gubernaculum; *e*, telamon, diagrammatic; *f*, posterior end of female; *g*, posterior end of female, showing length of vagina; *h*, eggs.

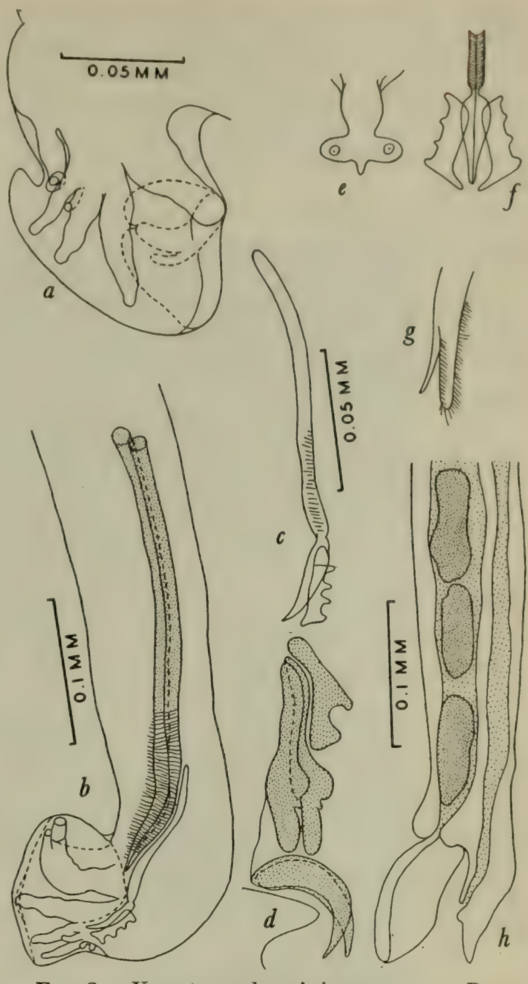

FIG. 2.—*Varestrongylus sinicus*, n. sp.: a, Bursa of male, lateral view; *b*, posterior end of male, showing length of spicules; *c*, gubernaculum; *d*, ventral part of telamon, lateral view; *e*, dorsal ray; *f*, terminal part of gubernaculum, diagrammatic; *g*, distal end of spicule; *h*, posterior end of female.

the proximal ends. Distal ends split for a distance of 0.05 mm. Gubernaculum, 0.140–0.150 mm long, consists of proximal and terminal portions divided by a constriction located about 0.1–0.110 mm from the proximal end, terminal portion ending in a sharp point. On each side of the terminal portion, originating at about the level or slightly below the constriction, is a more or less rectangular shaped sclerotized structure, its dorsally directed edge serrated. As in many other members of the subfamily there is a rather complicated telamon present. One of the striking features of this telemon is that it has two sharply pointed

prongs projecting into the dorsal parts of the lateral lobes of the bursa. On first view these prongs appear to originate from and to be part of the terminal portions of the dorsal ray, but closer study shows that they have no connection with the dorsal ray but are a part of the telamon.

Female.—22 to 24 mm long and 0.175 mm wide. Vagina 1.150 mm long. Lips of vulva swollen and prominent. Vulva about 0.125 mm from tip of tail. Body narrows abruptly immediately posterior to vulva. Anus 0.045–0.050 mm from tip of tail. Well-developed provagina present.

Hosts.—Sheep and goats. Specific identity of sheep and goats unknown.

Location.—Small bronchioles and lung tissue.

Distribution.—Lanchow, China.

Specimens.—U.S.N.M. Helm. Coll. No. 45105, 45106.

Remarks.—*Varestrongylus sinicus* differs from *Varestrongylus pneumonicus* Bhalerao, 1932, the only other member of the genus, principally in the shape of the gubernaculum and its appendages.

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Bhalerao, G. *On some nematode parasites of goats and sheep at Muktesar.* Ind. Journ. Vet. Sci. and Anim. Husb. 2 (3): 242–254. 1932.

Boev, S. N. *Sintetokauliusy legkikh ovets Alma-Atinskoi oblasti Kazakhstana [The nematodes of the genus Synthetocaulus parasitic in Alma-Ata Territory, Kasakhstan].* Rabot. Gel'mintol. (Skrjabin) [Papers on Helminthology (Skrjabin)], 1937: 55–62.

ZOOLOGY.—*Unusual abnormalities in sea-stars.*[1] W. K. Fisher, Hopkins Marine Station, Pacific Grove, Calif. (Communicated by Waldo L. Schmitt.)

The following notes concern two species, *Linckia columbiae* Gray and *Pisaster ochraceus segnis* Fisher, which are characteristic of the fauna of southern California. Although I have examined sea-stars in almost galactic numbers, I have never before encountered these deviations from the normal.[2]

Linckia columbiae Gray[3]

Figs. 1, 2.

This species, which ranges from southern California to the Galápagos Islands, is characteristically asymmetrical. Most specimens have one or more rays in the process of regeneration, and it is possible for an autotomized ray to grow a new disk and four new rays. Such are known as comet forms. In the specimen under discussion (U.S.N.M. No. E. 6606) a new individual is being budded off from the dorsal surface of the shortest ray, to which it is attached by a very short peduncle about 4 mm thick. The dorsal plates of the parent are in complete continuity with the plates of the young one, but in the latter all the normal categories of plates are perfectly differentiated. The young has two unequal madreporites, with a third in the process of separation from the larger. The parent has three madreporites. They vary from three to five in the species. The young has one papula to an area on the four rays but none on disk; the parent has a maximum of 10 or 11. There are four ambulacral furrows with their bordering granules Owing to dessication it is not possible to determine whether mouth and anus are present.

Pisaster ochraceus segnis Fisher[4]

Fig. 3.

In the specimen shown in Fig. 3 (U.S.N.M. No. E 6607) the rays have fused nearly to tip along the *lateral* part of the abactinal surface. The dorsal surface of the fused rays has two series of carinal spines, the space between which is equal to about half width of the two other dorsolateral areas. The superomarginal plates of the fused halves as well as the inferomarginal, are

[1] Received April 22, 1945.

[2] I am indebted to Mrs. Edward H. Anderson, formerly Miss A. E. Blagg of the Hopkins Marine Station staff, who found these specimens among *miscellanea zoologica* at the Compton, Calif., Junior College. They were probably taken not far from San Pedro, Calif.

[3] W. K. Fisher, *Asteroidea of the North Pacific and adjacent waters.* U. S. Nat. Mus. Bull. 76, pt. 1: 242, pl. 48, figs. 1–7. 1911.

[4] *Idem*, pt. 3: 171, pl. 73, figs. 4, 8; pl. 75, fig. 6; pl. 84. 1930.

on the ventral surface and are in somewhat less regular alignment than normally. While on the outer halves of the fused rays there are three series of actinal plates, on the inner halves there are but two. Along the middle of the ventral surface between the two series of superomarginals is a narrow area of irregular plates, carrying spines very similar to the superomarginal spines, which must be reckoned as a part of the abactinal system.

The coelomic cavity of the two rays is in perfect continuity, and there is only one pair of hepatic caeca.

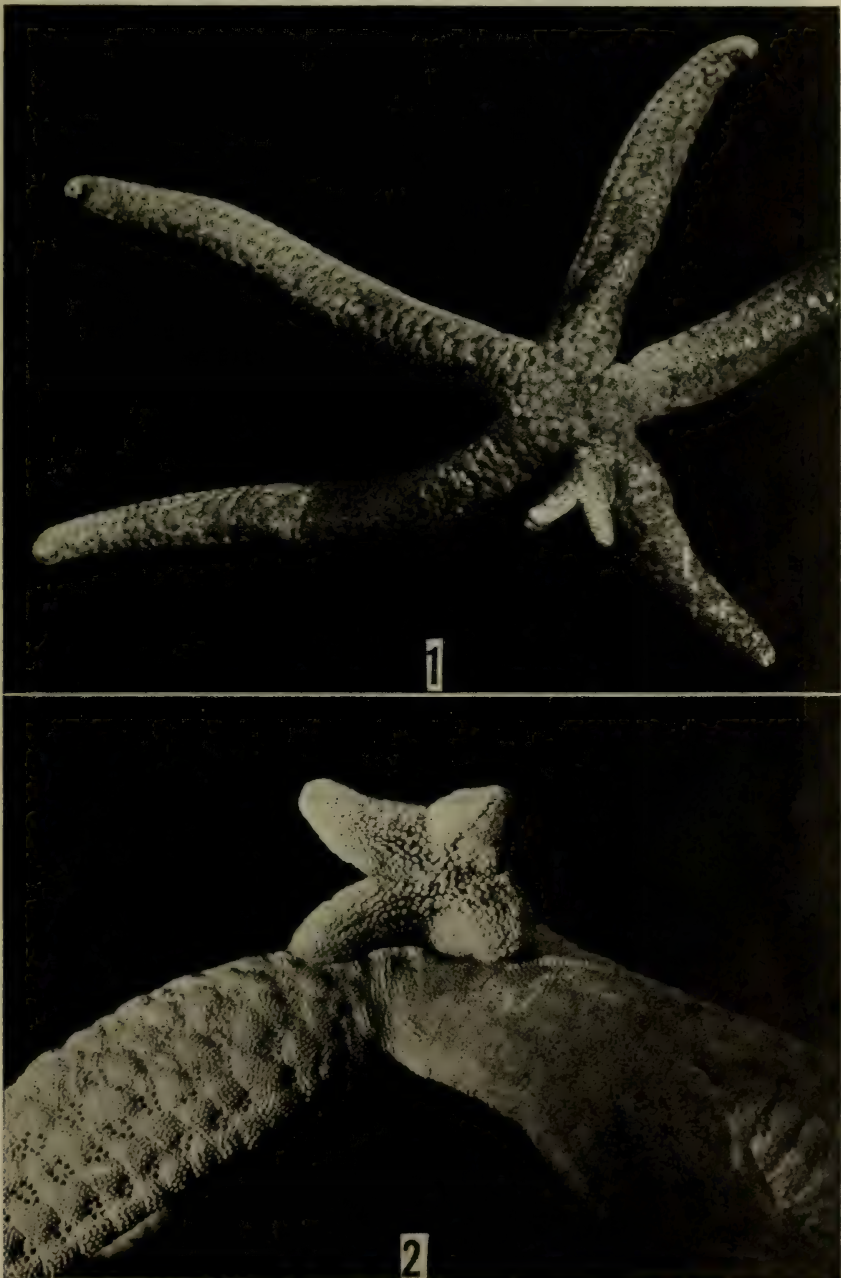

FIG. 1.—*Linckia columbiae* Gray, ×1.3, showing position of adventitious young. FIG. 2.—Same, ×4, actinal surface of the bud. U.S.N.M. No. E. 6660.

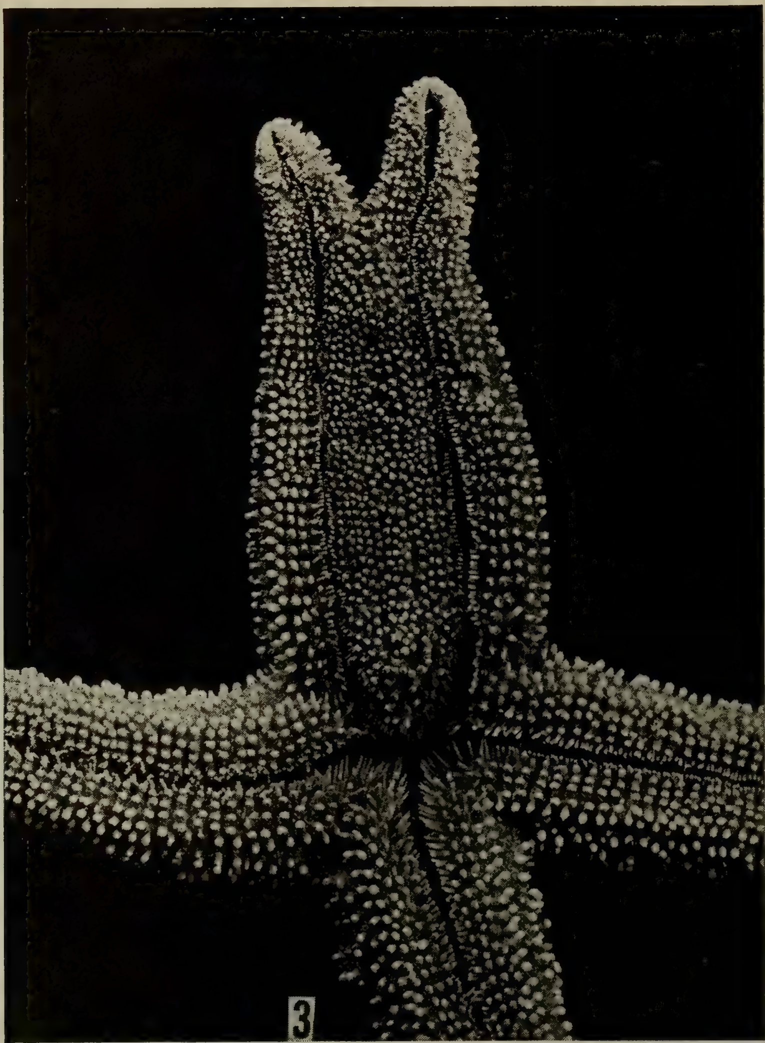

FIG. 3.—*Pisaster ochraceus segnis* Fisher, slightly larger than natural size. Actinal surface showing coalesced rays. U.S.N.M. No. E. 6607.

PROCEEDINGS OF THE ACADEMY

NEW MEMBERS

There follows a list of persons elected to membership in the Academy by vote of its Board of Managers, during the Academy year 1944, who have since qualified as members in accordance with the bylaws of the Academy. The bases for election are stated with the names of the new members.

RESIDENT

WILLIAM RICHARDS BLAIR, technical adviser, Automatic Electric Co., Washington, D. C., in recognition of work in meteorology, especially in the field of upper-air observations and research, for having devised the radiometeograph, and for numerous improvements in rapid communication equipment and technique.

AUBREY KEITH BREWER, physicist, National Bureau of Standards, Washington, D. C., in recognition of contributions to chemical physics and in particular researches on the photoelectric properties of catalytic surfaces, chemical action in the electric discharge, mass spectrographic analysis, and isotopes.

CHARLES NILES CLAIRE, U. S. Coast and

Geodetic Survey, Washington, D. C., in recognition of contributions to geodesy and especially researches in cooperation with Dr. Oscar S. Adams connected with the establishment of State plane coordinate systems and with special map projections.

LOUIS WADE CURRIER, geologist, U. S. Geological Survey, Washington, D. C., in recognition of services in the science of geology.

JEWELL JEANETTE GLASS, U. S. Geological Survey, Washington, D. C., in recognition of contributions to mineralogy.

CHARLES KEITH GREEN, chief, Division of Tides and Currents, U. S. Coast and Geodetic Survey, Washington, D. C., in recognition of contributions to physical hydrography, chart construction, and tide and current phenomena.

MARTIN GREENSPAN, materials engineer, National Bureau of Standards, Washington, D. C., in recognition of work on stress distribution in engineering structures.

SAM RUTHERFORD HALL, histologist, Bureau of Dairy Industry, Beltsville, Md., in recognition of work on the physiology of lactation and reproduction.

JOHN PEABODY HARRINGTON, ethnologist, Bureau of American Ethnology, Washington, D. C., in recognition of discoveries in linguistics.

GEORGE WILLIAM HUNTER, III, parasitologist, U. S. Army Medical School, Washington, D. C., in recognition of extensive researches on parasites of game fishes, including a monograph on the North American Caryophyllaeidae.

PHILIP BURKE KING, geologist, U. S. Geological Survey, Washington, D. C., in recognition of work in stratigraphy and structural geology in west Texas, New Mexico, Virginia, and Tennessee.

SAMUEL LEVY, physicist, National Bureau of Standards, Washington, D. C., in recognition of contributions to mechanics, with particular reference to the analysis of aircraft structures.

FLOYD ALONZO MCCLURE, research associate, Smithsonian Institution, Washington, D. C., in recognition of botanical explorations in China and contributions to our taxonomic knowledge of the bamboos of the Orient and of South America.

HAROLD HALL MCKINNEY, pathologist, Bureau of Plant Industry, Soils, and Agricultural Engineering, Beltsville, Md., in recognition of contributions to botany and plant pathology and in particular for investigations with plant viruses.

ALVIN GREENE MCNISH, physicist and magnetician, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D. C., in recognition of contributions to geophysics, in particular to researches on the earth's magnetic field and its variations.

ATHERTON H. MEARS, engineer, U. S. Weather Bureau, Washington, D. C., in recognition of work in developing new instruments, particularly meteorological instruments.

ALFRED MÉTRAUX, anthropologist, Bureau of American Ethnology, Washington, D. C., in recognition of contributions to the ethnology of South America and Polynesia.

ROBERT RUSH MILLER, assistant curator of fishes, U. S. National Museum, Washington, D. C., in recognition of original research made known in several scientific contributions on the ichthyological fauna of the western desert regions of North America.

MAURICE ALLISON MOOK, assistant professor of sociology and anthropology, American University, Washington, D. C., in recognition of contributions to the historical ethnology of the southeastern Algonquin tribes of Tidewater Maryland, Virginia, and the Carolinas.

WILLIAM WARD PIGMAN, chemist, National Bureau of Standards, Washington, D. C., in recognition of studies on the mechanism of action and specificity of the glycoside-hydrolyzing enzymes.

MARGARET PITTMAN, bacteriologist, National Institute of Health, Bethesda, Md., in recognition of contributions to the serological typing of *Hemophilus influenzae* which stimulated the use of type specific antiserum, and other studies of *Hemophilus influenzae.*

LESLIE ADRIAN SANDHOLZER, bacteriologist, U. S. Fish and Wildlife Service, and lecturer, University of Maryland, in recognition of contributions to bacteriology especially in regard to bacteriophage and enteric bacteria; also, contributions to knowledge in the field of environmental sanitation and public-health aspects of the fishery industry.

KENNETH LEE SHERMAN, physicist, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D. C., in recognition of contributions to atmospheric electricity, in particular to the design and development of instruments.

LEO ALLEN SHINN, chemist, Bureau of

Dairy Industry, Beltsville, Md., in recognition of contributions to biochemistry and especially work on amino acids and proteins.

Francis Albert Smith, chemist, National Bureau of Standards, Washington, D. C., in recognition of contributions to the physical chemistry of gases and flames and to knowledge of the properties of substances dissolved in liquid ammonia.

Otis William Swainson, chief, Division of Geomagnetism and Seismology, U. S. Coast and Geodetic Survey, Washington, D. C., in recognition of contributions to the determination of the velocity and ray paths of sound waves in sea water and to topographic surveying.

T. Ivan Taylor, chemist, National Bureau of Standards, Washington, D. C., in recognition of contributions to physical chemistry and in particular work on the separation of isotopes and their application to chemical research.

Ernest Harry Vestine, physicist, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D. C., in recognition of contributions to geomagnetism with particular reference to the analysis of magnetic disturbances.

Harold Ernest Vokes, geologist, U. S. Geological Survey, Washington, D. C., in recognition of work on the Cretaceous and early Tertiary molluscan paleontology.

Henry Welch, chief, Microanalytical Division, Food and Drug Administration, Washington, D. C., in recognition of services to the science of biology, especially in immunology and in studying the effects of antiseptics, sulfonamides, irradiation, and penicillin on bacterial infections.

Harry Warren Wells, physicist, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D. C., in recognition of contributions to ionospheric research; development of apparatus for multifrequency ionospheric exploration extending our knowledge of worldwide characteristics and applying this information to theoretical analysis of the earth's magnetic field, together with its practical applications to radio wave-propagation.

Charles Arthur Whitten, mathematician, U. S. Coast and Geodetic Survey, Washington, D. C., in recognition of contributions to the science of geodesy and to practical astronomy.

William A. Wildhack, physicist, National Bureau of Standards, Washington, D. C., in recognition of work on aircraft instruments and in particular on research and development of corrugated diaphragms and on aircraft oxygen instruments.

Gordon Randolph Willey, anthropologist, Bureau of American Ethnology, Washington, D. C., in recognition of contributions to the prehistory of the southeastern United States and of Peru.

William Embry Wrather, director, U. S. Geological Survey, Washington, D. C., in recognition of his stimulating influence in geology and the other sciences.

NONRESIDENT

John Scott Andrews, parasitologist, Coastal Plain Experiment Station, Tifton, Ga., in recognition of contributions to our knowledge of the injurious effects of nematode parasites on sheep and cattle.

James Bennett Griffin, curator, Museum of Anthropology, University of Michigan, Ann Arbor, Mich., in recognition of research and publications on the ceramics of the aborigines of eastern America.

Thomas Forsyth McIllwraith, professor of anthropology, University of Toronto and keeper of ethnological collections, Royal Ontario Museum of Archeology, Toronto, Canada, in recognition of studies of the ethnology of the Indians of the northwest coast of Canada, studies in the material culture of Canadian Indians, annual lists of publications in anthropology of Canada, and of position as an outstanding Canadian anthropologist.

Robert L. Piemeisel, plant physiologist, Bureau of Plant Industry, Soils, and Agricultural Engineering, Twin Falls, Idaho, in recognition of outstanding research in plant ecology, especially ecology of desert and range areas of western United States.

Clifton Alfred Weslager, DuPont Corporation, Wilmington, Del., in recognition of contributions to Delaware prehistory and folklore.

F. G. Brickwedde, *Secretary*

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ETHNOLOGY.—*Some mnemonic pictographs relating to the Iroquois condolence council.*[1,2] J. N. B. HEWITT, late ethnologist, Bureau of American Ethnology, and WILLIAM N. FENTON, Bureau of American Ethnology.

The use of mnemonic pictographs by the Iroquois and cognate tribes has long been recognized by various writers, but hitherto the subject has not received the attention that its cultural importance merits. A thorough study, if properly done, should reveal the technique employed by the natives in adapting means to ends, showing how the Iroquois sought to obtain their needs by the readiest available methods. That the latter would change with time and place is obvious to anyone who considers even momentarily the long history of the Iroquois and their relations with Europeans. One might hope that such pictographs were drawn on bark or buckskin; he should not be disappointed to find them on paper. What is remarkable is that certain ideas persist, and they are expressed in changing media. Beyond brief references to its casual use in the works of early writers, very little of a descriptive or interpretive nature exists in printed sources accessible to the student concerning the picture writing of the Iroquois Indians; its extent and the purposes it was made to serve are therefore but little known.

In the present brief study we do not aim to cover the entire subject of Iroquois pictography. Rather, this paper attempts to learn how the Iroquois adapted pictorial designs to form mnemonic records of what they deemed the distinctive features of two component rituals in the Condolence Council, which is a convocation of the confederated Iroquois tribes for the purpose of condoling the relatives of deceased federal chieftains and filling the ranks with chosen candidates; the visiting unscathed tribes of the League conduct the ceremony, restoring the minds of the mourning tribes. When the League was founded the lawgivers decreed that no seat around the great council fire should remain vacant. Accordingly, the Condolence Council comprises five rituals of condolence and installation, among which the Roll Call of the Founders and the Requickening Address were remembered by the symbols that are discussed below.

On one of his many field trips to the Six Nations of Grand River in Ontario, Canada, Mr. Hewitt in 1920[3] fortunately acquired a

[1] Published by permission of the Secretary, Smithsonian Institution. Received May 28, 1945.

[2] This is the second of Mr. Hewitt's manuscripts relating to the Condolence Council of the Iroquois League to appear posthumously. The first, the Requickening Address of the Iroquois Condolence Council (this JOURNAL **34** (3): 65–85, 1944), introduces the subject and carries explanatory notes on the Iroquois Confederacy and its social organization that need not be repeated. Mr. Hewitt's original manuscript entitled "Mnemonic Pictographs of the Iroquois," much too broad a title for its contents, was never completed for publication. The unfinished paper, with notes for the balance comprising MS. No. 3502 in the Bureau of American Ethnology Catalogue of Manuscripts, has been entirely rewritten by the junior author, who began the work with the help of Simeon Gibson in the autumn of 1943 and completed it in May 1945 at Ohsweken, Six Nations Reserve, with the assistance of Cayuga Chief Alex General and Howard Skye. The former field work derived support from a grant in aid from the American Council of Learned Societies, the latter from the Viking Fund and the Smithsonian Institution.

[3] Since this paper is written from the viewpoint of the junior author, the third person denominates the senior author, who died in 1937, and the first person is reserved for the present writer. Opinions of the senior author I have labeled "J.N.B.H.," interpretations of Simeon Gibson appear as "S Gibson," those of Howard Skye as "H. Skye," and comments of my own are initialed. "W.N.F."

Mr. Hewitt was in the field annually from 1916

small well-worn memorandum book of about a dozen pages, of a kind that country grocery stores commonly furnished gratis to customers as advertising. On previous occasions Mr. Hewitt had observed this notebook in the possession of old Chief Abram Charles. Chief Charles, then an emeritus chief of the Cayuga tribe, consulted it frequently while he was engaged in reciting either the Roll Call of the chiefs or the Requickening Address during sessions of the Condolence Council. The first of these rituals, the Roll Call of the Founders, is chanted; the other, the Requickening Address, is spoken, preferably in a rhythm which reminded Hewitt of blank verse. Chief Charles drew these arduous assignments because his contemporaries recognized that he knew the contents of these two rites and performed them accurately. Because the rites directly concern the dead and the living and because the origins of the League have acquired a holy aura, the Iroquois regard them as sacred, and performing the rituals publicly demands strict accuracy, since ancient custom enjoins that the celebrant must not err during the recitation; should he hesitate or stumble, another performer must be ready to continue; an error of this nature is construed as boding ill to all the people. Not only is it imperative to adhere strictly to the ordered sequence, but not to follow the established sequence confuses and confounds well-known political relationships that are basic to the functioning of the League and its institutions. It was thought that failure to follow the roll call of official titles, their grouping into classes, tribes, and moieties, and the political relationships of these groups as kin would vitiate the purposes of the chants.

Well aware that Abram Charles had great difficulty to read or write the simplest matter in English, Mr. Hewitt naturally was curious to know the contents of this small notebook to which Chief Charles constantly referred. So when a favoring opportunity presented itself Chief Charles was consulted about the matter. Hewitt was no little amazed to learn that this unpretentious notebook contained sets of mnemonic symbols or characters which had been devised ingeniously to indicate the number, the correct sequence of topics, and the roll call of federal titles comprising these two important chants.

There are eight pages of drawings. The envelope, in which Hewitt kept the pages mounted on larger sheets of paper (see footnote 3), contains pages from what appear to have been two notebooks. There are five pages on buff-lined paper measuring 8 by 14.5 cm and three pages on narrower coated stock, measuring 6.6 by 13.8 cm and bearing double pink lines at the top, of which one page (List No. 1) is dated "SEPT—1 1913." Apparently the latter drawings are of more recent date, to judge by the condition of the paper, but they are possibly copies of older drawings. The eight pages are occupied by 13 sets of drawings, which largely depict the upper portion of the human body. Clearly, some of the 13 sets are merely revisions duplicating some one of the other sets. Nevertheless, the entire group of drawings constitutes notes or memoranda for two of the main chants in the Condolence Council.

The first of the two chants or rituals involved here bears two titles since it has two aspects which the terms describe: Its first use is during the journey of the condolers from their home country toward the settlement of the tribe which mourns for its official dead; on the long journey representatives of the several condoling tribes intone the ritual as they slowly follow the path to the home of the stricken tribe, repeating the song day after day on the trail. This aspect of the ritual, therefore, in Onondaga was called *atahinón'ge*, "While journeying," or, in modern reservation parlance, "Going on the road." Its second aspect derives from repeating the ritual on arrival inside the meeting place, the longhouse of the mourning tribe, where the Condolence Council convenes. The term for the second aspect is *ne' ondathnonhsen'dedákhkwa'*, "that by which one passes through the house" (i.e., through the institution of the League).

to 1920, but he stayed in Washington throughout the fiscal year ended June 30, 1921. A letter envelope containing the pages from Chief Charles's notebook bears the legend: "Chief Abram Charles/ Books,/Ohsweken,/Ontario, Canada/1920."

Simeon Gibson rendered this term, "What a nation employs in calling at another nation's house." In this part of the ceremony the visiting singer leads the column of condoling chiefs into the longhouse of the mourning tribe, and then the singer alone paces to and fro reciting the Eulogy or Roll Call of the Founders of the League, which is the aspect of "Calling at the other tribe's house." The Roll Call is the roster of the 49(50) founders of the League,[4] their blood ties, and their political relationships; hence its English title. Hewitt adopted the descriptive caption "The Eulogy of the Founders of the League" as being more expressive of a ritual that lists the official names of its founders, with pertinent laudatory and historical comments interspersed after each of the names.

The second ritual involved in the drawings is the Requickening Address, which has been published in this JOURNAL. One set of pictographs, therefore, comprises memoranda for the Fourteen (or Fifteen) Matters constituting the condolences. Each one of the 14 symbolic human figures in this set (Fig. 6) represents one of the 15 topical sections, except one, of the great requiem address for elevating the minds of the stricken federal chiefs who are addressed as an individual. The Fourteen Matters respectively describe the 14 hurts or wounds inflicted on mortals by "that demonic Being that is faceless, Death—the Great Destroyer." Stricken in body and mind are the kindred who mourn. In the second place, with the 14 sections of the address the unscathed phratry of tribes performs vicariously acts of symbolic restoration to the faculties and bodies of the mourning phratry through the voice of their speaker. Since this part of the ceremony prescribes for the bodily and mental effects of death, it deals with affected organs and faculties. The Iroquois believe that bitter grief induced by death of kindred sets up in the mourner a blood deficiency that debilitates the organs and enfeebles the mind. So by the loss of a chief his kindred are depressed in mind and their vitality is lowered.

Before attempting to interpret the drawings of Chief Charles, one must understand some basic principles operative in the political structure of the League. One must also understand that the code of Condolence Law compels inflexible adherence to set forms in the two rites under discussion. Rather than repeat the exposition of these two sets of principles here, the reader is referred to the 1944 edition of Mr. Hewitt's paper on "The Requickening Address of the Iroquois Condolence Council," to which are appended notes on the Iroquois Confederacy and its social organization. For the benefit of those who do not have access to that paper, we may state briefly that the principles of blood kindred, duality (with mutual service between reciprocating units of society), relative age, and sex, as they operated in society as it was lived by the village band, were projected beyond the local group to the level of the tribe, and from the tribe to the confederacy. Thus what individuals do in the band, whole tribes perform in the confederacy. Tribes apply kinship terms to other tribes: they are related as mothers or little mothers (i.e., mother's sisters), daughters and sons, older sisters and younger sisters, elder brothers and younger brothers, and mother's brothers (uncles), father and little father (i.e., father's brother), father's sister, in some tribes, and mother or little mother, in others.[5]

Relations of consanguinity and affinity which the founders of the League ascribed to chiefs of the several tribes must be constantly kept in mind when reciting the chants. In performing the Eulogy or Roll Call the celebrant must remember three things: the song, the list of names, and the relationships between the names that fill out the verses of the chant. Therefore, the

[4] Hewitt contended with the Cayugas that there were but 13 titles on the Onondaga list, the last person, *Skana'wati*, having two names correlative with peace and war functions. Instead of 14 Onondaga chiefships, since one man occupied two statuses and performed two roles, this left but 49 chiefs on the federal roster, not 50 as the Onondagas contend and as there were in later times.

[5] The terms for aunt and uncle are found only among the Seneca and Tuscarora and do not occur in Mohawk, Oneida, Cayuga, and Onondaga dialects; the reason for this is not known. —J.N.B.H. It is my impression that these findings do not accord with Goldenweiser's data for the kinship of the Six Nations.—W.N.F.

chanter must observe carefully the correct sequence of terms in the ritual, Evidently the task was not an easy one for an unassisted memory, and gradually mnemonic aids like the pictographs which are the subject of this paper came into use.

Chief Charles's drawings are of the same order as the symbols in wampum belts, although the latter are perforce geometric; the practice of using drawings is like holding a series of twigs or marked counters or sticking tallies upright in the ground; the drawings serve a similar purpose to tally sticks notched to indicate a period of days or points to be enumerated in speaking; and we are reminded of the series of wampum strings of graduated arrangement and distinct color patterns that accompany burdens of the Requickening Address. Moreover, the old chiefs carried canes. Sometimes the chiefs carved memoranda on canes as on other sticks to remind them of stations in a long address involving a dozen or more points. Again, the chiefs commissioned craftsmen to make canes and adorn the surfaces with symbols appropriate to reminding celebrants of the significant stations in a ritual. Thus, among the extant examples of such record canes, the Cayugas formerly had a Roll Call Cane, now in the Cranbrook Institute of Science, that the appointed Eulogy singer carried in the same ceremony as these drawings to denominate the 50 titles of the chiefs who founded the League.[6]

With the sole exception of the one page of illustrative drawings as symbols for the Fourteen Matters of Requickening (Fig. 6), the remaining notebook pages of pictographs refer to the Roll Call of chiefs. Four sets of these (Figs. 1–3 and one set not illustrated), however, stand for the Mohawk and Oneida rosters of chiefs. The Onondaga roster appears clearly once on the same page as the Seneca roster (Fig. 4); the latter is not represented again in recognizable form; but the Onondaga characters appear again on List No. 2 (Fig. 5),[7] but out of order. The Cayuga chiefs are not illustrated except by a series of dots (Fig. 5), to which we return in a moment; Abram Charles, being a Cayuga chief, could remember the roster of his own tribal council.

In some respects the grouping of chiefs and their relationships to one another is more fundamental than their titles. At least the Iroquois ritualists have isolated the patterns of spatial arrangement which they illustrate in a number of ways. One page of Chief Charles's notebook contains a series of dots, ... (Fig. 5), spaced in the sequence 2-3-3-2, which is the grouping of Cayuga chiefs in council. Another page carries out similar sequences for all of Five Nations.

On the latter sheet, Mohawk and Oneida appear at the right, one over the other in sequences of threes. On the left at the top are the Cayuga chiefs. Beneath them on a slant are the Seneca, four groups of two. The Onondaga list runs across the bottom of the page to the left of the Oneida, reading from right to left.

(Cayuga) ../.../.../..	(Mohawk) .../.../...
(Seneca) ../../../..	
(Onondaga) ../.../../././......	(Oneida) .../.../...

Knowing in part the sequence of chiefs from the Roll Call, and using these data, we can reconstruct the grouping of chiefs and their relationships, which, if Chief Charles's notes are read from right to left, work out as follows:

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[6] W. N. FENTON, *A Cayuga condolence cane with pictographs denominating the founders of the Iroquois League* (MS.).

[7] List numbers derive from the original paper. To avoid confusion a correlation of List numbers and Figure numbers follows:

List No. 1. Mohawk and Oneida titles (Fig. 1). Older buff paper.

List No. 1. Onondaga and Seneca titles (Fig. 4). Newer coated stock, and dated "SEPT—1, 1913."

List No. 2. Onondaga titles (5–14; 1–6), and Cayuga groupings (Fig. 5). Older buff paper.

List No. 2. Mohawk and Oneida titles, with Seneca titles poorly drawn at bottom (not illustrated). Newer coated stock.

List No. 3. Mohawk and Oneida titles (Fig. 3). Newer coated stock.

List No. 4. Mohawk and Oneida titles (Fig. 2). Older buff paper.

Groupings of chiefs in five tribes (not illustrated). Older buff paper.

Mohawk: 3-3-3
Oneida: 3-3-3
Cayuga: 2-3-3-2
Seneca: 2-2-2-2
Onondaga: 6-1-2-3-2*

* (Hewitt gives 1, making 13.)

We find, therefore, 19 groups (classes) or committees of chiefs in the Conferederate Council. The arrangement of dots to represent these groups in Chief Charles's notebook, moreover, follows a design for laying down kernels of corn that he and other Iroquois ritualists employed when instructing Eulogy singers in the Roll Call of chiefs and in teaching their relationships. Precisely the same pattern is found in the grouping of pegs on the Cayuga Condolence Cane in Cranbrook Institute.

Evidently when the ritual of Journeying on the path to visit the longhouse of the mourning chiefs took final form, the Roll Call contained 50 titles, represented by 49 chiefs, according to Hewitt and the Cayugas. Of these 50 titles, 9 belonged to the Mohawk, 8 to the Seneca, 14 to the Onondaga (represented by 13 chiefs), tribes on the Male or Father side (the Three Brothers side); and 9 to the Oneida and 10 to the Cayuga, tribes of the Female or Mother side (the Four Brothers side, later, including Tuscarora, Tutelo, and Delaware) of the council fire of the League. This means that one tribal phratry or moiety of the League council, that of the Father side (also called Elder Brothers), claimed 31 titles, represented by 30 federal chiefs; and only 19 titles belonged to the Mother side (also called Offspring, or Younger Brothers).

Besides these two larger tribal moieties the great body of chiefs comprised 19 smaller, intratribal groupings (above), expressing similar blood and political relationships within the several tribes. At once these lesser groupings furnished the timber and the plan with which the founders erected the confederate structure. Within these lesser groupings no unit is larger than three; oftener the group includes two; one large committee of six comprises three units of two. Thus the tripartite grouping and the basic pattern of duality intersect in the social and political organization of the League of the Iroquois tribes as the warp and the woof of the Great White Mat of the Law, which spreads out beneath their political structure. Two men sit across the symbolic council fire from each other as cousins, or they sit together on the same side of the fire as brothers opposite a third who is their cousin. From the fireside council of the Mohawk Turtle clan, to the tribal council of the Mohawk Nation, to the confederate council of the League, the same patterns of tripartite grouping and reciprocity between moieties prevailed.

By way of illustration Hewitt summarized the social and political organization of the Mohawk and Oneida tribes. Each tribe had three clans: Turtle, Wolf, and Bear. With the Oneida, the order was Wolf, Turtle, and Bear. With the Mohawk Turtle and Wolf are political brothers, forming a moiety, one side of the tribal duality, and Bear sits alone. But among the Oneida, Wolf and Turtle are political brothers, forming one moiety, and Bear the other.

The Mohawk Turtle clan chiefs and the Oneida Wolf clan chiefs, in the councils of their respective tribes, functioned as chairman or presiding officer, and as such they took no part in deliberations of the council beyond hearing and determining whether the proceedings of the session were legal and conformed to established custom; if so they confirmed the decision; otherwise they referred the matter back to the council for further deliberation and action, perhaps with pertinent corrective comment. Tribal councils, organized on this pattern and functioning as described, resemble, Hewitt thought, an American court composed of judges and jury.

In confederating to form the federal council the founders of the League adopted this tripartite form of the dual tribal council, but they rearranged constructively the internal political structure of the Onondaga, whose duty it was to preside at the sessions of the federal council. From among the 14 Onondaga chief statuses the founders of the League appointed an executive committee of five who were called the Firekeepers. It was the function of the Firekeepers to decide what disposition should be made of the resolutions and de-

cisions arising out of the deliberations of the 36 chiefs representing the four other tribes of the League, and accordingly to advise the presiding chief, *Dehadodáho*, leading Onondaga chief, what action he should take. In possessing the Firekeepers, theoretically the Onondagas as presiding tribe of the League council in no way controlled the deliberations of the body, no more than did the presiding clans in the tribal councils of the Mohawk and Oneida, on which the confederate structure was modeled. The report of the committee called Firekeepers constituted a judgment, and when the presiding chief *Dehadodáho* pronounced a judgment the case was closed.

The following diagrams illustrate spatial arrangement of clans and the functions of the chiefs in relation to the symbolic council fire. It will be seen at a glance that the same pattern obtains at the level of the tribe and of the League. We give the number of chiefs for each grouping in the Mohawk and Oneida tribal councils. At the left is the Male of Father Side of the council fire, and the right is the Female of Mother Side.

MOHAWK TRIBAL COUNCIL

Turtle Clan
Three Chiefs
Judge

Wolf Clan Three Chiefs *Legislative*	Tribal Council Fire	Bear Clan Three Chiefs *Legislative*
These are Brothers to Turtles above.		These are Cousins to Turtles and Wolves across the fire.

ONEIDA TRIBAL COUNCIL

Wolf Clan
Three Chiefs
Judge

Turtle Clan Three Chiefs *Legislative*	Tribal Council Fire	Bear Clan Three Chiefs *Legislative*
These are Brothers to Wolves.		These are Cousins to Wolves and Turtles across the fire.

FEDERAL COUNCIL OF THE IROQUOIS LEAGUE

The Onondaga Tribe
Fourteen Chiefships,
held by 13 chiefs
Firekeepers
Judge

The Mohawk Tribe Nine Chiefs *Legislative*	League Council Fire	The Oneida Tribe Nine Chiefs *Legislative*
The Seneca Tribe Eight Chiefs Doorkeepers *Legislative*		The Cayuga Tribe Ten Chiefs *Legislative*
The Mohawk and Seneca tribes are Brothers to the Onondaga tribe. These three call the Oneida and Cayuga tribes "Offspring" or "Nephews."		The Oneida and Cayuga tribes are Cousins to the three tribes across the fire. They are "Offspring," being on the Mother Side of the council fire. Including adopted tribes in later times they became the "Four Brothers Side." They call the three other tribes of the Three Brothers Side, "Fathers' clansmen" or "Uncles."

In the old council of life chiefs on the Grand River, which held court until 1924 at Ohsweken on Six Nations Reserve, the above diagram would have been reversed, with Mohawk and Seneca sitting east of the "fire," the Onondaga as Firekeepers in the center, His Majesty's agent to the north, and the Oneida and Cayuga with appended tribes sitting west of the fire:

ONEIDA	H.M.S.	MOHAWK
	X	
	ONONDAGA	
CAYUGA Tuscarora Delaware and Tutelo		SENECA

Under the latter arrangement, which is the same as the first only turned about for true orientation, Onondaga-Mohawk-Seneca constituted the Three Brothers Side,

and the Four Brothers Side comprised Onondaga-Cayuga-Tuscarora-Delaware (and Tutelo). The latter three, being dependent tribes, adopted by the Cayuga and the Oneida, had no voice in the federal council. The remnants of the Nanticoke were included among the Delaware.

Now let us take up the lists of chiefs which Chief Charles illustrated with his notebook drawings.

THE MOHAWK PICTOGRAPHS

Four sets of drawings may be ascribed to this tribe: List No. 1 (Fig. 1), List No. 2 (not shown), List No. 3 (Fig. 3), and List No. 4 Fig. 2). Hewitt is responsible for numbering the lists (see footnote 7).—W.N.F.

1. *Tekarihhókenh,* "It separates or divides the matter."

The first name on the Roll Call, and the first name on the Mohawk tribal roster, is represented on List No. 1 by a forked stick; on Lists Nos. 2 and 3 by a man's head with a forked tongue protruding from the mouth, as if to illustrate the interpretation now current at Six Nations, "Of two opinions." Apparently, the symbol for this name is lacking on List No. 4.

2. *Hayenhhwénhtha'',* "He sifts with a bark sieve."—J.N.B.H., or "Early riser" (S. Gibson).[8]

On the Mohawk List No. 1, this chief is represented by three dots vertically arranged (Fig. 1), on List No. 3 by a man's head and torso having five dots on the body to represent "the sieve" (J.N.B.H.) (Fig. 3); List No. 2 has a bisected oval figure, probably an error, taking the place of the third name; and the second Mohawk title appears first on List No. 3 as an irregular figure with dots "to depict the sieve" (Fig. 2).

3. *Sha'tekarihhwáate',* "Matters of equal height, words of equal length."

Three vertical lines topped by a horizontal line depict this chief on Mohawk List No. 1 (Fig. 1), showing that the three items are of equal import. List No. 2 has a similar symbol of but two vertical lines with a horizontal line across the top. A man's head topped by a heavy horizontal line represents this chief on List No. 3 (Fig. 3). List No. 4 is less clear; the drupe-shaped symbol is capped by a heavy horizontal line, defining a limit to its height (Fig. 2).

A hiatus occurs here in all the lists, indicating that these three, the Turtle clan chiefs, stand together apart from the next three.

4. *Sharenhhóowane',* "He the great tree trunk."

A tall trunk of a tree having three long roots stands for this name on List No. 1 (Fig. 1), and

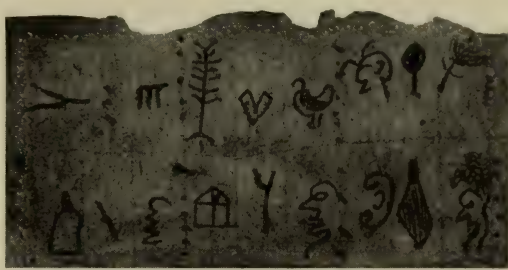

Fig. 1.—List No. 1: Mohawk and Oneida titles.

in the same manner on the remaining lists, but with four roots.

5. *Teyonhhéhkonh,* "It lives by two life-givers," or "Double Life."

The name of this title is represented by two V-shaped characterters on List No. 1 (Fig. 1), the one set above the other, enclosing two dots. The remaining lists show the head and torso of a man having two heart-shaped devices on the breast. "Double life" was the idea that Chief Charles evidently intended.

6. *Ohenhhe'góonah* (Oa.) or *Orenhre'kóowah* (M.), "Great White Eagle," or, possibly, "Great Canada Goose."

On all four lists of pictographs, this chief is depicted by the figure of a bird, facing to the left. On these lists the character of the bird resembles a fowl; on the Cayuga Condolence Cane at Cranbrook Institute, however, its aspect is that of a dove or hawk, facing the other way.

Here a hiatus of vertical dots on all lists signifies completing the roll of the Wolf Clan chiefs, who are cousins to the next three.

[8] Hewitt did not comment on this new interpretation, which differs from that in his article *Hiawatha* (Handbook of American Indians, 1912 ed.). From Onondaga Chief John Buck of Six Nations Reserve, Mr. Hewitt had in 1931, "He who sifts with a woven bark sieve" in the following dialectical forms: Hayęnhhwáth'ha' (Oa.), Hayénwathha' (Hayɛwathha') (S.), Hayenh'wathha' (third syllable whispered) (C.), Rayénhwathha' (M.), La—(Oe.).

Fig. 2.—List No. 4: Mohawk and Oneida titles.

7. *Tehenna'kariine'*, "His two horns are moving along," or "Dragging Antlers."

The antlers figure prominently in the symbols of all four lists: on List No. 1 (Fig. 1) a human head with antlers over its forehead; on List No. 2, merely a small round object bearing deer's antlers; on List No. 4, a poorly drawn human head with deer antlers. Chief Charles intended apparently to delineate a chief carrying his two antlers, the horns of office.

8. *Hahstawen'serôntha'*, "He attaches rattles to it."

This title is represented on List No. 1 by what appears to be an outline of a turtle shell rattle, held upright; the same is crudely drawn on List No. 2; on List No. 3, an outline of a rattle bears two dots on the shell; and on List No. 4 the attempt to draw such a rattle is crude, to say the least. The rattle is the key to this name.

9. *Sosgohharóowane'*, "He the great branch." (Hewitt's MS. gives "He the great quantity of drift-wood" or, just as meaningful, "He has a large cadaver," but these interpretations make no sense.—W.N.F.)

The outline of a tree branch appears clearly on all the lists. Surely this is what Chief Charles had in mind.

This is the number of Mohawk chiefs, marked on all lists by a series of vertical dots.

THE ONEIDA PICTOGRAPHS

The following chiefs are the "Offspring" of the first. (The Roll Call continues, but we enumerate the chiefs of each succeeding tribe separately, e.g., 10/1, 19/1, 33/1, and 43/1.)

10/1. *Ho'datchéhde'*, "He bears a quiver (by a forehead strap)" or, with a slight change in pronunciation, "He bears a fawn (buckskin pouch) by a burden strap—J.N.B.H.[9] "He carries a quiver on his shoulder," or, simply, "Carries a quiver" is the usual meaning—W.N.F.

In all the drawings the quiver idea is prominent. What is possibly intended for a quiver with attachment for carrying appears on List No. 1 (Fig. 1). A human head and bust bearing a quiver on the shoulder occurs on List No. 2 (not illustrated); the same appears on Lists Nos. 3 (Fig. 3) and 4 (Fig. 2).

11/2. *Kanonhkwen'yóoton'*, "One has set upright several ears of corn," "Standing ears of corn," or "Standing corncobs."

The second Oneida title is depicted on the first three lists by a straight line inclined at its top to the left; on List No. 4 is a drawing of an ear of corn, also inclined to the left at the top.

12/3. *Teyohhá'kwente'*, "It has a gullet" or "Difficult swallower." "Between the openings (of the forest)"—S. Gibson. In the Deganawíidah legend, this chief passes without leaving an opening in the forest.

On List No. 1 this title is depicted simply by a crude drawing representing the profile of a human face; a pronounced double chin appears on a head and torso of List No. 2; several dots

[9] Quiver (*gahéskaa'*) *gɛ̈'dá'tčhɛ'*, buckskin pouch); but a new born deer is owiiyɛ', and deer (skenóndon'); "he carries the body" would be *hoya'dagéhde'*. The quiver that this old Oneida chief carried was made evidently of buck or fawn skin—S. Gibson.

direct attention to the neck, probably to denote its opening, on the drawing of a head and body in List No. 3; and the double chin appears again on List No. 4.

A hiatus occurs here in all the lists. This is the number of Wolf Clan chiefs.

13/4. *Shonónhsese'*, "His lodge is very long."

A drawing of a house with or without a doorway appears on all four sets of drawings: a house (Fig. 1), a tall gable marked with a line for the doorway (List 2), two lines indicating doorway in gable (Fig. 3), and merely a house gable in List No. 4 (Fig. 2).

14/5. *Tehone'okén'ah* or *Daona'rokén'ah*, "He the small forked root."

In all four sets of drawings this chief is depicted by a drawing of a fork. In Onondaga and Cayuga this name changes to "Two words (voices) meet," (dwennaigén'a (Oa.), dodwennaigén'ah(C.).—S. Gibson.

15/6. *Hatya'tonnénhtha'*, "He swallows an object (body)" or "He drugs his body." The name is probably corrupted.

In all the sets of drawings this chief is depicted as swallowing an object: a small cross, an unrecognizable object protruding from the mouth of the figure (List No. 2), a 3-pronged object protruding from the mouth (Fig. 3), and List No. 4 (Fig. 2) shows the full figure of a man, and protruding from his mouth is an object which ends in a small loop.

This ends the second group of Oneida chiefs, the chiefs of the Turtle clan, and a line or series of dots indicates the hiatus.

16/7. *Tewatahonhténnyonk*, "Pairs of ears hanging," or "Pendulous vibrating ears (as if slit)" *Dewatahenhdénnyonk* (Oa.).—S. Gibson.

The ear is the prominent feature in all four sets of drawings. An enormous ear appears on List No. 1; the remaining sets show a human head and neck, with a very large ear. Simeon Gibson, citing the Deganawíidah Legend of the founding of the League, referred to the first appearance of this chief as having enormous ears that were probably slit for insertion of feathers, leaves, and other decorations, which, once removed, left the helix and lope to hang vibrating. "Moving his ears" is the current interpretation.

17/8. *Kaniya'taasháayen'*, or *Ronya'dasháayonk* (M.), *Ganiya'dasháayen'* (Oa.), "A pouch (or bag) lying (resting)," or possibly a "fawn skin" (J.N.B.H.). In Onondaga, *ga'dashä'yen'* is a "lying pouch." But Simeon Gibson and a Mohawk matron independently gave "Slow swallower" for their respective dialectical variants of this name.

The pouch or bag theory is supported by Chief Charles's drawings. List No. 1 (Fig. 1) depicts the name by a lozenge-shaped object that Hewitt interpreted as a hanging pouch or skin; on List No. 2 the object resembles a quiver and is banded across the middle; List No. 3 (Fig. 3) has a similar design; and the character is a hanging pouch on List No. 4 (Fig. 2).

18/9. *Honwatsatónhhonh*, "One has covered him with fog." *Honwahtcadónhwi* (Oa.), "He is covered with mist."—S. Gibson.

The head of a man shrouded in mist appears on all four lists. On List No. 4 it is a pot-bellied man.

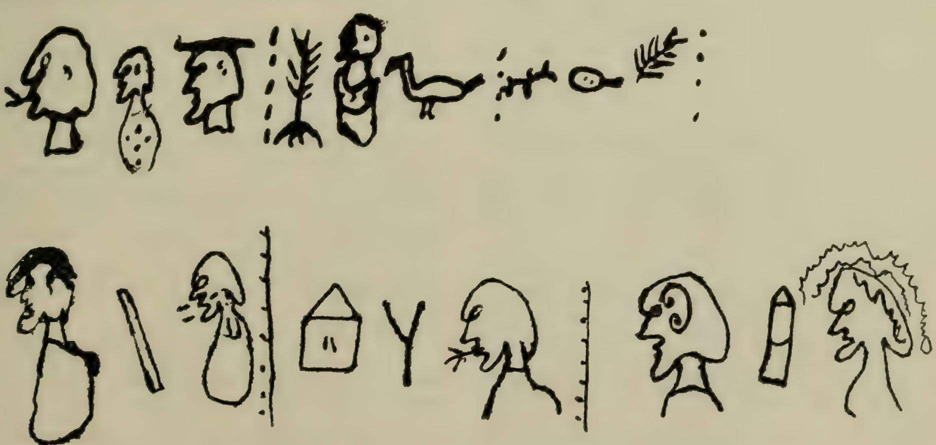

Fig. 3.—List No. 3: Mohawk and Oneida titles.

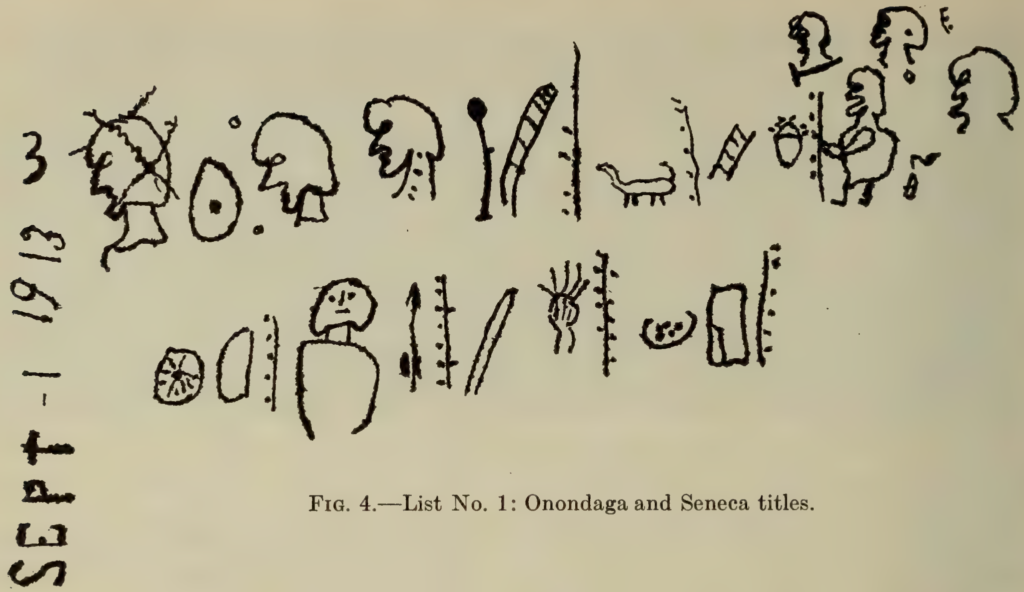

FIG. 4.—List No. 1: Onondaga and Seneca titles.

This group were the Bear clan chiefs. This was the roll of Oneida chiefs.

[For some reason Hewitt omitted an analysis of the Onondaga and Cayuga lists of drawings, and his notes for this manuscript (B.A.E. No. 3502) do not contain the rosters of chiefs' names for these two nations. However, Hewitt obtained from Chief Charles in 1917 a complete text in Onondaga for the Eulogy or Roll Call of the Founders of the League, together with independent lists of chiefs whose clan eponyms are differentiated (B.A.E. MS. No. 1281a, 54 pp. $6\frac{1}{2}\times9\frac{1}{4}$ inches, 15 pp., 8×10 inches). Also, we find a typed, revised list (No. 3558, 3 pp. 8×10 inches—Charles, 1917) of "Federal Chiefships and their kinship eponyms." From the latter sources, this paper has been completed.—W.N.F.]

19/1. *Dehadodáhho'* (Oa.) or *Thadodáahho'*, "Ensnarled."

Only one set of drawings depicts the Onondaga chiefships (Fig. 4). Ragged lines cross over the head of a man to represent the leading Onondaga chief.

20/2. *One'säh'henh* (Oa.) or *Gane'säh'henh*, "A tied bundle."—S. Gibson; "In the center of a coil, circle," or possibly of a "stretched hide"; but Onondaga opinion holds that the name means "on the middle of a field, *gane'sää'hen.*"—H. Skye.

The character for this name is a circle with a dot at the center. Possibly it represents a bundle. On the Condolence Cane of the Cayugas the symbol suggested to Howard Skye a hide stretched on a hoop.

21/3. *Dehatgáhdons* (Oa.) or *Thaatgáhdons.* "He looks both ways (or around); On watch."

A drawing of a head in which the eye is prominent stands for this chief.

22/4. *Honya'dadji'wak* (Oa.) or *Hoya'dadjii'wak*, "His throat is sour (or black)"; or "His sour body."—H. Skye.

Again we find the drawing of a chief's head; four dots direct attention to his throat which apparently is inflamed or soured by gall.

23/5. *Awe'génhhyat* (Oa.), "On the surface of the water."

A line with a knob on top perhaps represents a plant.

24/6. *Dehaya'tgwáae'* (Oa.), or *Thayadgwáae'*, "On one side of its leaning body" (?); "Both his wings are outspread."—H. Skye.

A ladderlike figure leans to the right.

This title is the last of the Firekeepers, and a line with dots along its left margin indicates a separation of this group from the next name.

25/7. *Hononwiéhdih* (Oa.), "He conceals it" or "Covers it"; "He causes it to sink."—H. Skye.

This chief has special responsibilities. He is keeper of the wampums for the confederacy, and since he is also called *ne' hogwaho'góonah*, "He the Great Wolf," he is represented by a miserable drawing of his eponym. This chief

stands alone; a line with a margin of dots separates him from the remaining Onondaga chiefs.

26/8. *Gowennen'shéndonk* (Oa.) or *Gawanne'séndonh*, "Her voice is hanging," or "Hanging strings."—S. Gibson.

Whatever this title means, and it is impossible to know what about one-quarter of the titles meant four centuries ago, it is depicted by a stepped character that leans to the right, composed of two leaning lines enclosing four oblique lines.

27/9. *Hahhíihhon'* (Oa.), "He spills it" or "He tips it."

This name is also obscure and the character for it is not clear. The drawing is possibly intended for a vessel spilling over.

The latter two names are grouped together separated by dots and a line from the next four. They belong to the Deer clan.

28/10. *Hoyonnyénnih* (Oa.), "He was made to do it."—H. Skye.

The next four characters are crowded into a corner of the notebook page and one can not be certain in what order to read them. On the assumption that the top two and the first character at the bottom are meant to be followed by three dots to segregate them as a class apart from the last, then a man's head atop an object drawn across the base of the neck may stand for this title.

29/11. *Shodegwáasen'* (Oa.) or *Shodegwáahshon'*, "He the bruiser," or "He smashes it again."—S. Gibson; "Bruised repeatedly."—H. Skye.

At the lower left there is a full-size figure of a man of gigantic proportions, but the figure at the upper right does not help.

30/12. *Shagogénhhe'* (Oa.) or *Shagogénhhee'*, "He saw the people."—S. Gibson; "He sees her (them) occasionally."—H. Skye.

These three chiefs of the Eel clan comprise a group to themselves.

31/13. *Ho'sähhǻahwih* (Oa.) or *Ho'sähǻhhwih*, "He bears a aloft a torch."—S. Gibson; but possibly just a name, although the Onondagas sometimes discuss the possibility of *Hoda'skwishä'hwih*, "He bears a tomahawk in his belt."—H. Skye.

This is the name that determines whether there are 49 or 50 chiefs in the League. The name appears in the first writing of the Abram Charles text for the Eulogy (p. 16), but at the bottom of the same page occurs, "1923 He says again *Ho'sä'hā''hwi'* is not a title of a Federal Chief." Nevertheless, this name was recounted as part of the Roll Call, an Onondaga chief was installed in this title, but in recent times a controversy arose between the Cayugas and the Onondagas as to whether this title belonged to a separate individual or to the next chief.[10]

The last character, a male head, must stand for two titles.

32/14. *Sganawáadih*, "Across the swamp," "Over the river," or "Across the rapid."

The text implies that the last two names were additions to the roster in later times. One was a great war chief whose body was riven in twain, being both a warrior and a councilor; hence the argument that one man occupied both offices. The first is of the Turtle clan. Hale says that *Skanawati* was the divided personality (p. 161). The Turtle clan claimed this name.

THE CAYUGA PICTOGRAPHS

33/1. *Dega'ényonh* (Oa.) or *Haga'ényonh* (C.), "Wonderer."

Possibly because he was a Cayuga chief himself, Abram Charles evidently did not feel the need to provide himself with a set of drawings for remembering the Cayuga list. His notebook contains merely a design of spaced dots to indicate the number and groupings of the Cayuga chiefs: . . . . (2–3–3–2). The characters across the top of the same notebook page (Fig. 5) are of the Onondaga titles, but out of order. Simeon Gibson held this opinion, which

[10] On the question of the number of chiefs in the League, Mr. Hewitt left this note:

"With the final amendment to the constitution of the Iroquois League, admitting and installing the last two chief warriors of the Seneca as federal chiefs, the final number of *Rodiyánehr*, Federal Chiefs, became 49, which is the only number recognized by the ritual of the Eulogy of the Founders. This number was never increased, notwithstanding the adoption of the Tuscarora, the Nanticoke, and the Tutelo with their chiefs with sittings in the Federal Council Chamber. The most probable reason for this failure to add these official titles to the said ritual seems to be because the newly adopted chiefships had nothing whatever to do with the founding and institution of the League.

"Every one of these 49 Federal officials belonged to some one *ohwachira* or uterine family, which probably had its own peculiar tutelary name taken from some bird or animal. One or more of these *ohwachira* was organized into a higher unit—the clan. The three Oneida and the three Mohawk clans have three of these *ohwachiras*. . . . "

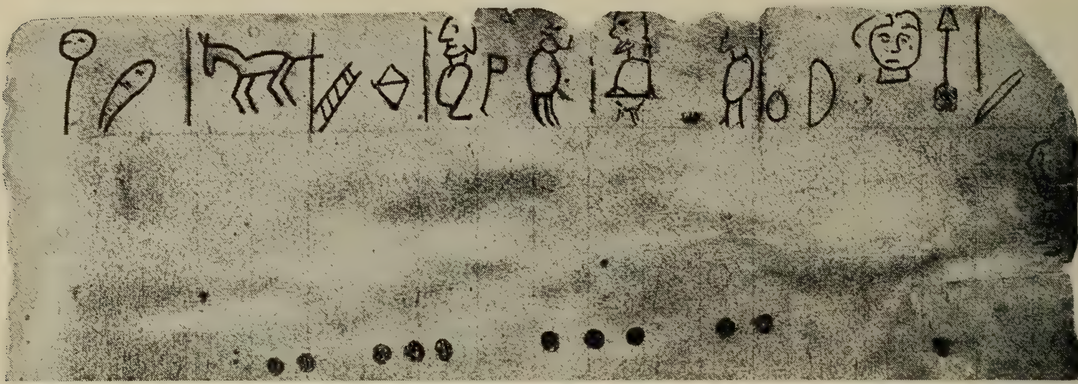

FIG. 5.—List No. 2: Onondaga titles (5–14; 1–6) and Cayuga groupings.

can be substantiated by comparing this set with the other Onondaga pictographs (Fig. 4). Taking the Onondaga list above, the order is: 5 6/7 /8 9/10 11 12/13* 14//1 2 3 4. Some difficulty is encountered in adjusting the characters to the first and the last titles. Further, it is evident that when Chief Charles made this set of drawings he then regarded the thirteenth title, that of the disputed *Ho'sähdahwih* as a separate office. Therefore, it may be that the list that we described in enumerating the Onondaga titles was of later composition.

34/2. *Gadji'nondawéheh* (Oa.), *Gadjinon'dawéhheh* (C.), or *Dji'nondawéeyah*. The interpretation of this name is uncertain. "Coming on its knees" (Hale), "Calls a summons" (?).—S. Gibson, and "Manipulating bugs."—H. Skye.

This and the previous title belong to the two leading chiefs of the Cayuga tribe, who are as father and son to each other. They preside as judges in the Cayuga council. The first is of the Bear clan, the second of the Hawk or "Ball" clan.

35/3. *Gadagwáadjih* (Oa.) or *Gadagwáase'* (C.), "Mashed," or "Softened."—S. Gibson.

This title and the next two belong in a group who are related as "brothers."

36/4. *Shoyónwees* (Oa.) or *Shonyónwes* (C.), "His guts are long." "He has a long wampum belt" (Hale).

37/5. *Hadya'sénhne'* (Oa.) or *Hadyásénne'*, "He repeats (or rehearses) it." "He puts one on another, piles it on" (Hale).

These are a group to themselves. The first two belong to the Bear clan; the third to the Turtle clan.

38/6. *Deyoenhhyóngoh* (Oa.) or *Thowenhhyóngoh* or *Deyoronhhyóngoh* (C.), "Reaches the sky."

39/7. *Deyothhowéhgwih* (Oa.), "Doubly cold."

40/8. *Deyawenhethhon'* (Oa.), "Two things happen," "Double event." *Thaonhwéthon'*, "Mossy place" (Hale).

This is the number of colleagues in this group, but the next one belongs in the same phratry, although they are called cousins to each other. Six and Seven are Wolf clan chiefs; Eight is of the Killdee, Small Plover, or Snipe clan. Hale ascribes it to Wolf.

41/9. *Hadonhdahhéhha'*, "He shoulders a log (?)."—H. Skye; "Crowding himself in" (Hale).

This title belonging to the Large Plover lineage is in the same phratry as the preceding group, and his cousin across the fire is his colleague who follows. Hewitt's notes say that the latter two are brothers, but the text declares them "Cousins." The last chief is of the Bear clan.

42/10. *Desgáahe'* (Oa.) or *Desgáhhe'* (C.), "He does something (?)."

It is not clear what this chief does. The present holder of the title, Chief Alex General of the Upper Cayuga band at Sour Springs, Six Nations Reserve, holds that the name means "More than Eleven."

This ends the Cayuga roster.

THE SENECA PICTOGRAPHS

[In turning to the last tribe of the League we once more return to Hewitt's manuscript.]

43/1. *Skanyadáiyo'* or *Sganyadáiiyo'*, "It is a beautiful lake (Handsome Lake)" or, literally, "It is a very large lake." [As given these names are Onondaga or Cayuga, not Seneca forms.]

There are two sets of Seneca pictographs. On Seneca List No. 1. (Fig. 4), this title is depicted by a circular design having radial lines from its center to the perimeter. On List No. 2 the character is merely a circle.

The Seneca councillors are linked in pairs of opposite moieties. As such they are cousins to each other. The first title belongs to the Turtle clan, the next to the Great Plover or Snipe.

44/2. *Sha'tekáonhyes,* or *Tca'degaénhyes,* "Two skies of equal length."

On both lists this title is represented by a character resembling the letter **D**; it is sometimes represented by two arcs of the celestial sphere. A line having dots along its left margin appears on one list, a line on the other, to separate the first pair of titles from the second.

45/3. *Shagen'djóowanenh* or *Shagen'djóowane'*, "He of the large forehead."

This chief is depicted on both lists by a full face that accentuates the brow region over the eyes.

This title belongs to the Hawk clan, being in the same moiety as the second title, and his colleague, who sits across the fire as cousin of the first two, is of the Bear clan.

46/4. *Satyénowaht* or *Sadyénawat,* "Do thou take hold of it"; "He grasps it."—S. Gibson.

Hewitt placed this name fourth on the list, although it is sixth on the Seneca roster in the Eulogy or Roll Call text by Chief Abram Charles and in a combined list of the same date (1917) attributed to Chief Charles and to the Mohawk chief Seth Newhouse.

On List No. 1 (Fig. 4) the fourth title is represented by a character that neither Hewitt nor I could interpret. On the strength that the character stands for the name listed by Hewitt for it, Simeon Gibson ventured that the vertical line was a pole grasped by two hands. This idea gains some strength from List No. 2. An arrow, however, appears at this same place on the Cayuga Condolence Cane of Andrew Spragg, and the same object was possibly intended by Chief Charles. Since these two old Cayugas lived as neighbors on the Six Nations Reserve and used to collaborate in teaching the roll call to younger men, we may assume that they agreed on the order of Seneca chiefs. Moreover, Chief Charles was also a poor draftsman. In view of the texts, the verbal lists of the Chiefs, and the Cayuga Condolence Cane, we find also:

46/4. *Ga'nóogai'*, a title for which neither of us has discovered a satisfactory translation. The title suggests the homophonic word *gá'non* (S.), "arrow," which possibly helped the chiefs of recent years to remember the name. In Seneca the title is *gá'nogai'*, in contrast to the Onondaga above, which they translate as "chewer, biter, or killer." At least the name has this meaning to the Tonawanda Senecas.

This title belongs to the Turtle clan.

Fig. 6.—The Fourteen Matters of Requickening.

A line on both lists separates the second and third pair of Seneca chiefs.

47/5. *Onishayenén'ha'* or *Nishaanyénen't* (?). Simeon Gibson interpreted the former as meaning, "A man leaning nearly over," the latter as "Falling day," which it means to the Tonawanda Senecas. Small Plover or Snipe clan claims it.

On the first list a long object inclines to the right; on the second set of drawings a simple line inclines to the right. In either case the verb in this name denotes something falling from an upright position.

48/6. *Ka'nóokai'* (J.N.B.H.). (Cf. 46/4).

To Hewitt this character, the fifth on the Seneca List No. 1 (Fig. 4), suggested a stump having sprouts and two roots, but the design on the second set of drawings he found still less recognizable. The forty-eighth symbol on the Cayuga Condolence Cane of Andrew Spragg is similar in appearance to the character on Chief Charles first set of drawings (Fig. 4). It is a hand or bear paw or turtle foot having five claws or fingers. Both the Charles text for the Eulogy or Roll Call and a combined list of chiefs by Charles and Seth Newhouse would attribute this character to the name *Sadyénawat* (46/4), which we repeat here:

48/6. *Sadyénawat,* "Grasps it," which is consistent with the drawing as interpreted. Bear clan.

Another line segregates the latter pair of titles from the last two, which belong to the Doorkeepers of the Longhouse of the League.

49/7. *Kanonhkari'dáhhwi'* or *Ganonhgei' dáawi'*, "Its hair is singed," or "It broils." Snipe clan.

Hewitt interpreted the drawings on both lists as representing a bed of live coals.

50/8. *Teyoninhhoká'wenh, Deyoninhhogáa'-wenh,* "It keeps the doorway open"; literally, "It holds up the door-flap," referring to the ancient bark or skin door hinged at its top in the longhouse of the League. "Open Door" is the simpler rendering of Hale, and of Howard Skye.

This official is symbolized by characters representing an open doorway.

"This is the roll of the founders of the Great Peace; Hail Grandsires."

THE SYMBOLS OF THE FOURTEEN MATTERS

There remains to describe, only the set of symbols for remembering the 14 Matters of Requickening, which are perhaps the most interesting of the lot (Fig. 6). The Requickening Address is already in print, so the task of collating the drawings and the burdens of the address is not difficult. The list of burdens as given by Chief Charles faces a plate of the wampum strings that accompany the messages of condolence on pp. 78–79 of our previous article (this JOURNAL **34**). Chief Charles covered one page of his notebook with 14 drawings, mostly crude outlines of the human form in the same style as his drawings of the chiefs' titles. Each of the drawings (Fig. 6) stands for one of the sections of the great requiem address for Condolence and Installation of Chiefs in the League. Only one symbol is lacking. There is none to represent death of a chief by murder.

Through the awful devastation of Death the phratry of the deceased chief have lost their faculties and their organs have been damaged; these are restored to them in the following stages:

1. *Ogáhthri,* "One's eyes"—drawing of a man pointing to his eyes.

2. *Hahondagáronde',* His ear openings: Hearing—drawing of a stoop-kneed man with large ear.

3. *Dehanya'dóogen,* "Where is throat forks," his throat is full: Speaking—drawing of a man with round object in his throat.

Here three vertical lines indicate a hiatus; so many matters are recounted At the Wood's Edge where the mourners meet the condoling phratry.

4. *Eya'dagónwah,* "within his breast (body)" —drawing of a man with sketchy internal organs pointing to his mouth.

5. *Ondyendákkhwa',* "One's customary resting place": The bloody husk mat bed—drawing of rectangular object.

6. *Dayó'gaah,* "The deep darkness of grief" —drawing of man with deep halo around his head.

7. *Wa'hodronhyáhdon',* "He has lost sight of the Sky": Loss of the Sky—drawing of long-necked man seeking the sky.

8. *Wa'hodrahgwáhdon',* "He has lost sight of the Sun"—moon-faced figure seeking the Sun.

9. *Heyo'daágwáinda',* "At the Grave, at the mound of fresh earth"—drawing at lower left to represent dirt piled on grave.

10. or 11. *Dewáhshen niyóihwaks,* "Twenty

matters," the cost for homicide or (11), *deyonshdjisdadónhkwa'h,* "Around the fire place," at the hearth of the home: the Council Fire—an &-shaped character with what may be intended for 20 in the loop and three marks following. [Double numbering arises if No. 10, Murder is omitted.]

12. *Onthonwi'sas; hohsken'engéhda'*, "Woman and Warrior." These are grouped together in the Requickening Address, but apparently the third figure with long hair in the lower set of drawings is the Matron; the next wearing a hat is Warrior.

13. *Hoyáaneh,* "The Federal Chief"—the latter, possibly.

14. *Hyáhden de'aonhwendjana'gówas,* "Anything can happen on earth"—even suicide or insanity: the Mind's loss of reason—the next to the last drawing seems to have been intended to represent dementia.

15. *Gahashráhee'*, "The Torch"—the last figure may be intended for a torch of hickory rind such as was formerly used to illuminate night councils. But it may also be intended to represent a "short string." The name of the last string in Requickening is also *gahásh*εε', "light," being the short string at the end of the set. According to Howard Skye, at the end of the ceremony the short string is put over the pole for both tribal phratries to take up if any danger arises, when they say of it, "*dewakdá'a henganonhsókden'*, very quickly the news of it passes through the house (League)."

So ends the Condolence Council.

PALEONTOLOGY.—*Four new species of fossil cyprinodont fishes from eastern California.*[1] Robert R. Miller, U. S. National Museum.

The fossil fish fauna of the desert region of eastern California has hitherto received no serious attention. During my detailed studies of the living fishes of this area (Miller, 1943*a*, *b;* 1944) fossils were available for comparison with the Recent forms. Although the material is rather fragmentary it contains at least three distinctive species and one other that, though incompletely preserved, is apparently without a living representative. A careful survey for fossil fish remains is needed and would no doubt reward the investigator with important finds.

The material described below was lent by the Department of Paleontology of the California Institute of Technology, the Museum of Paleontology of the University of California, and the University of Michigan Museum of Paleontology. I am grateful to the authorities of these institutions for allowing me to examine and report upon their specimens. Dr. Carl L. Hubbs aided in the identifications and read the manuscript. J. R. Alcorn, of Fallon, Nev., kindly obtained comparative material of *Fundulus nevadensis* (Eastman) from the Lahontan beds in the vicinity of Hazen, Churchill County, Nev. Curtis J. Hesse, late curator of the Museum of the Agricultural and Mechanical College of Texas, kindly supplied advance information on the nature and disposition of the Death Valley material, on which he had done some preliminary work.

[1] Excerpt from a dissertation submitted in partial fulfillment of the requirements for the degree of doctor of philosophy in the University of Michigan. Published by permission of the Secretary of the Smithsonian Institution. Received April 20, 1945.

Family Cyprinodontidae: Killifishes

This group is best represented by material from Death Valley. I also had for comparison good specimens of the cyprinodont described as *Parafundulus nevadensis* from the Lahontan basin by Eastman (1917, p. 291, pl. 16, fig. 2; pl. 17; pl. 18, fig. 3), herein regarded as a species of *Fundulus*.

Genus **Fundulus** Lacépède

Fundulus curryi, n. sp.

Types.—The holotype (Fig. 1), a specimen approximately 44 mm in standard length, California Inst. Tech. no. 10239, Loc. 335, was collected by H. Donald Curry. It is a nearly perfect specimen except for the fact that the head end is crushed and represented chiefly by impression. Enough of the details are clear, however, to allow definite statements to be made concerning the size of the jaws, eye, etc. Nos. 10240, 10247 (smaller slab), and 10249, all from locality 335, are designated as para-

types. Nos. 10242 and 10246, from the same place, are also referred to *curryi.*

Horizon and type locality.—Reportedly lower Oligocene beds of the Tertiary Titus Canyon formation; 3 miles southeast of Chloride Cliffs in the Funeral Mountains, T. 15 S., R. 1 E. (Furnace Creek quadrangle), on the east side of Death Valley National Monument, Inyo County, Calif. The assignment of these beds to the lower Oligocene is very questionable. Preserved with the *Fundulus* is a single specimen referrable to *Cyprinodon,* a genus of recent origin previously unknown in fossil form.[2] This specimen is described in detail on following pages. The presence of a *Cyprinodon* in these beds strongly suggests that they are no earlier than Late Pliocene. In a letter dated December 18, 1942, Edwin C. Alberts, naturalist of Death Valley National Monument, stated that the type locality of the Titus Canyon formation is definitely Oligocene. This determination is based on the skeletal remains of a titanotherium. However, Mr. Alberts wrote that the place where the fish remains were discovered is several miles distant from Titus Canyon proper and "the dating of this site as Titus Canyon Formation was on purely lithologic grounds."

Diagnosis.—A *Fundulus* with the dorsal fin inserted very slightly in advance of the anal and with both of these fins posterior in position, the dorsal with 14 to 15 rays, the anal with 15 to 16 rays. The body and caudal peduncle are short and deep. There are about 30 to 31 vertebrae including the hypural.

Description.—The holotype has the dorsal inserted slightly in advance of the origin of the anal fin, with 14 or possibly 15 rays. A line connecting the point of origin of dorsal and anal fins makes an angle of about 85° with the body axis. The anal fin, with 16 rays, is rather long and rounded. Both of these fins are located far back on the body, well behind its midpoint. The small pelvics lie about midway between the tip of the snout and the caudal base, and consist of 6 (?) rays. The pectoral fins, both crushed, have at least 14 and probably 15 or 16 rays. The end of the caudal fin is missing, but enough of the rays are present to indicate a count of at least 19 and probably 20 principal rays (the branched rays plus 2). The length of the head enters the standard length about 3.6 times, and the body depth, over the origin of the dorsal fin, enters this distance 3.5 times. There are 10 or 11 precaudal and 20 caudal vertebrae, making a total of 30 to 31 vertebrae. The length of the base of the anal fin is about equal to the depth of the caudal peduncle, and enters the length of the peduncle about 1.5 times. The anal base is almost as long as the distance from the anal to the pelvic origin. The depth of the peduncle enters its length about 1.4 times. The lower jaw is strong and projecting, the eye large.

No. 10240, a paratype of *curryi,* has the posterior half of the body missing and the head crushed. The standard length, estimated by multiplying the head length by 3.5 (the ratio of head length to standard length in the holotype), was about 65 mm. The dorsal fin is inserted very slightly in advance of the anal, the line connecting the origins of these fins making an angle of about 87° with the body axis. The dorsal fin has 14 or 15 rays; the anal fin has approximately 16 rays; the pelvics are definitely 6-rayed. The pectorals are badly crushed but probably have 15 or 16 rays. The body depth is 3.0 in the estimated standard length. This fish is very deep-bodied forward, like big males of *Crenichthys,* a living cyprinodont of eastern Nevada (Hubbs, 1932, pl. 1; Hubbs and Miller, 1941).

No. 10249, also a paratype, has the dorsal, anal, and pelvic fins intact. The standard length of this specimen is estimated to have been approximately 66 mm (distance from anal to pelvic origins, 11 mm, times 5.5). The dorsal has 14 or 15 rays, the anal 15 or 16. A line connecting the origins of these two fins makes an angle of 85° or 86° with the body axis, as in other specimens of *curryi.* The pelvics are 6-rayed. The depth of the body at the dorsal origin enters the estimated standard length 3.1 times.

A few scale imprints, most prominent about the base of the dorsal fin in this specimen give information concerning the size, shape, and structure of the scales in *curryi,* and the age of this individual. This is the only specimen of *curryi* on which I was able to find any trace of

[2] *Cyprinodon* (?) *primulus,* based on scales only, was recently described by Cockerell (1936, pp. 3–4, fig. 1) from the Tertiary of northern Argentina. It seems unlikely that the scale figured by Cockerell even belonged to a cyprinodont fish, and it very definitely is not to be referred to *Cyprinodon.*

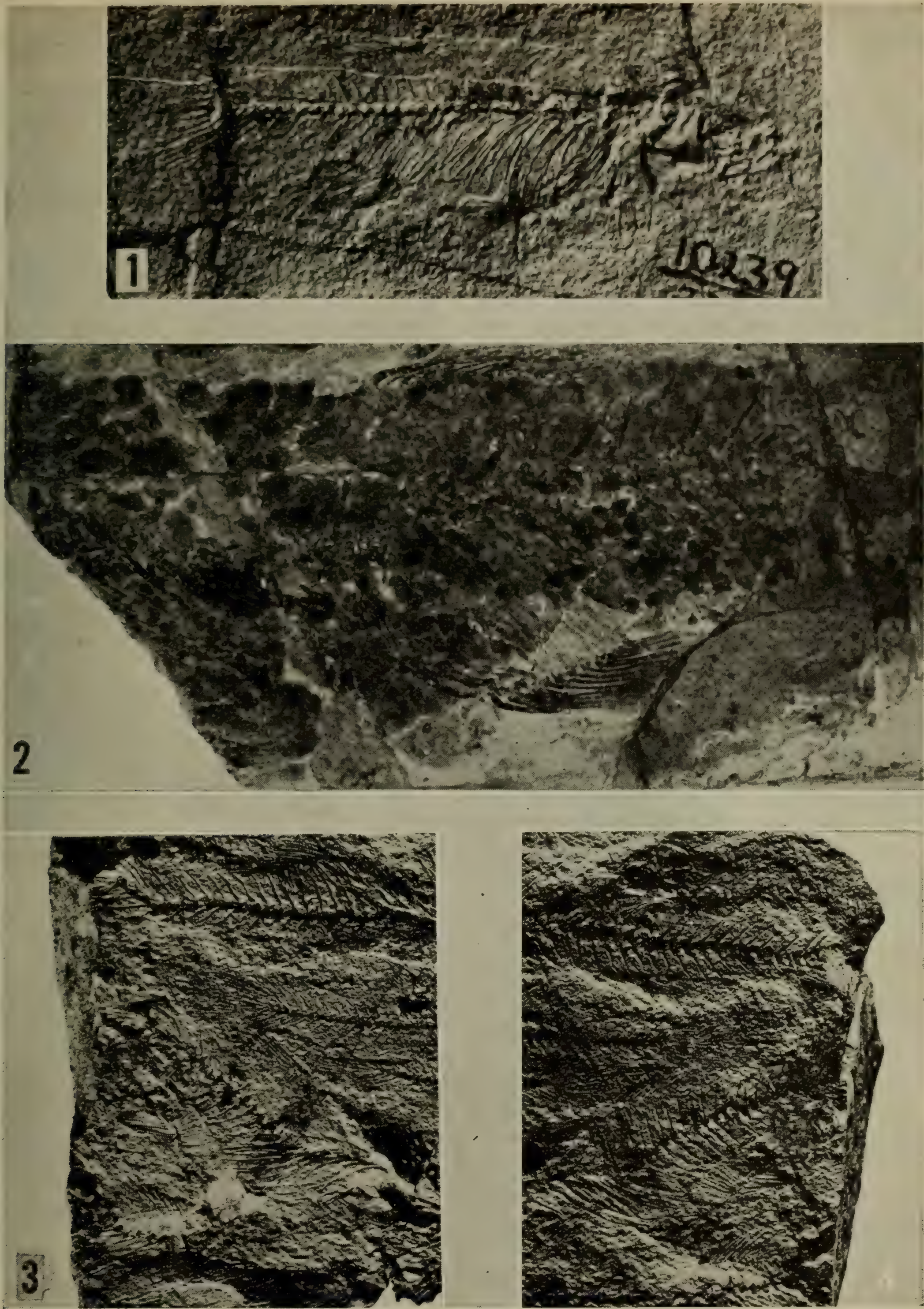

Fig. 1.—Holotype of *Fundulus curryi*, California Inst. Tech. no. 10239, about 44 mm in standard length. Fig. 2.—Holotype of *Fundulus eulepis*, United States National Museum no. 16883, estimated length 93 mm. Fig. 3.—Left half of holotype of *Cyprinodon breviradius*, California Inst. Tech. no. 10245, estimated length 33 mm., lying at an oblique angle on the matrix, the anterior end pointing downward toward the right lower corner and the posterior part terminating near the middle left center. Above the type are two well defined, partial specimens referred to *Fundulus eulepis* (see text) and parts of others which may belong to that species. Fig. 4.—Right half of holotype of *Cyprinodon breviradius*, representing the mirrored image of the opposite half shown in Fig. 3.

squamation, and this was made possible only by the use of very bright light. These scales have 10 to 11 radii, are imbricated, and have numerous circuli—as in *eulepis*. The focus is near the scale center. One scale near the posterior end of the incomplete specimen has a single year mark, indicating that this fish was in its second year and that there were marked seasonal differences in temperature. The scales are similar in size to those of *eulepis* and *davidae*, described below.

No. 10247 (smaller slab) is also designated a paratype of *curryi*. The pelvics, anal, and caudal are largely intact and enough of the body in the region of these fins is present to indicate that the specimen was deep-bodied. There are about 16 rays in the anal fin and six in each pelvic fin. The length of the anal fin base is a little difficult to discern but it appears to enter the length of the peduncle about 1.5 times, as in the holotype of *curryi*. The caudal vertebrae number 20 to 21.

The diagnostic differences between *curryi* and closely related fossil species of *Fundulus* in the West are given in Table 1. It differs from all of these in the greater number of anal fin rays and the correspondingly greater length of the anal fin base.

Compared with the only living species of *Fundulus* on the Pacific coast, *F. parvipinnis* Girard, ranging from Morro Bay, Calif., to Magdalena Bay, Lower California, and *F. lima* Vaillant, inhabiting springs at San Ignacio, Lower California, the fossil species is seen to differ greatly in the position of the fins. Both the dorsal and anal fins are more posterior in *curryi*, particularly the anal, whereas the pelvic fins are located midway between the caudal base and the tip of the lower jaw, as in the living species. This posterior shift in the unpaired fins but not in the pelvics stands out very clearly in the fossil for the pelvic fins lie well in advance of the anal, whereas in *parvipinnis* and *lima* the pelvics reach or nearly

TABLE 1.—DIAGNOSTIC DIFFERENCES BETWEEN FOUR SPECIES OF FOSSIL FUNDULUS FROM CALIFORNIA AND NEVADA

Character	*nevadensis* (Lahontan Basin)	*eulepis* (Death Valley)	*curryi* (Death Valley)	*davidae* (Mohave Desert)
Position of dorsal fin	Well in advance of anal; nearly midway between origins of pelvic and anal fins.	In advance of anal; about ⅓ distance from anal to pelvic origins.	Only slightly in advance of anal fin; very much nearer anal than pelvic fins.	Slightly behind anal fin.
Dorsal fin rays	11 to 12	13 to 14	14 to 15	11 or 12
Anal fin rays	10 to 13	13 to 14	15 to 16	11 or 12
Anal fin	Lobate.	Posterior rays elongated.	Broadly rounded.	Broadly rounded.
Base of anal into length of peduncle	1.7 to 1.9	1.7 to 1.9	1.4 to 1.5	2.3
Caudal peduncle	Long and slender, its depth about 2.5 in its length.	Moderately long and slender, its length about twice its depth.	Short and deep, its depth about 1.5 in its length.	Short and deep as in *curryi*.
Body	Long and slender its depth 6.5 to 8.0 in standard length.	Moderately long and slender, its depth about 4.5 to 5.0 in standard length.	Short and deep, its depth 3.0 to 3.5 in standard length.	Rather deep, its depth 4.0 in standard length.
Head	Very large and heavy, about 3.0 in standard length.	Probably similar to *curryi*.	Shorter, about 3.5 in standard length.	As in *curryi*.
Scales	Very small, circular, nonimbricated; about 4 radii and 5 circuli on largest; 65 or more in lateral series.	Moderately large, rectangular, rounded at apex, inbricated, with focus behind scale center; 8 to 12 radii, often exposed; many circuli; probably about 45 to 50 in lateral series.	Similar to *eulepis*.	Similar to *eulepis*.

reach the base of the anal fin. *F. curryi* also differs from these Recent forms in having more rays in the anal fin (10 to 13, usually 11 or 12, in *parvipinnis* and *lima*), and it appears to have been deeper-bodied than *F. p. parvipinnis* Girard, the northern subspecies of *Fundulus parvipinnis*. The southern subspecies, *F. p. brevis* Osburn and Nichols, and *F. lima* are about as deep-bodied as the fossil. In the several specimens at hand, there is nothing to indicate that the anal fin is elongated as it is in the males of *F. parvipinnis* (but not in *F. lima*).

Etymology.—It is a pleasure to name this new species in honor of H. Donald Curry, former park naturalist of Death Valley National Monument, who was actively engaged in studying the geology and paleontology of Death Valley.

Fundulus eulepis, n. sp.

Types.—The holotype (Fig. 2), estimated to have been about 93 mm long, is U.S.N.M. No. 16883, found by H. Donald Curry on December 5, 1935. It is more than half missing, but the body is intact between the pelvic fins and the middle of the caudal peduncle.

Horizon and type locality.—Furnace Creek Tertiary section; approximately 6 miles southeast of Furnace Creek Ranch in the Black Mountains (Furnace Creek quadrangle), on the east side of Death Valley National Monument, Inyo County, Calif. The original (U. S. Geological Survey) label reads, "Fossils are from beds interstratified with the Furnace Creek Tertiary Section."

Diagnosis.—A large *Fundulus* with the dorsal fin inserted well in advance of the anal, about one-third of the distance from the anal to pelvic origins, the dorsal and anal fins with the same number of rays (13 to 14), with a long, slender body, and with the anal rays elongated posteriorly.

Description.—The dorsal fin of this species, unlike that of *curryi*, is well in advance of the anal. In the holotype a line connecting the origins of the dorsal and anal fins makes an angle of approximately 79° with the body axis. The estimated length of about 93 mm was derived by multiplying the distance between the origins of anal and pelvic fins by 5.5, as the standard length is 5.5 times this distance in *curryi*. On the assumption that the pelvics lie about midway between the snout and caudal base, and estimating the position of the end of the hypural, a value of 90 mm is attained. Presumably this is a rougher estimate than that of 93 mm, because it is based on two (rather than one) assumptions. The close agreement indicates that the fish was probably not less than 90 mm in standard length. The dorsal fin has 13 or 14 rays, the anal fin, elevated and pointed posteriorly, has about 13 rays. The length of the last anal ray is two-thirds or more the length of the anal base. The pelvic fins, one of which is complete, have 6 rays. The pectorals and caudal are missing. The body depth enters the standard length about 4.7 times, indicating a slender body. The length of the anal base is approximately 1.9 in the length of the peduncle and 1.5 in the depth of the peduncle. The specimen is covered with scales, which are moderately large, possess 8 to 10 radii and many circuli, and have the focus behind the scale center. The radii are commonly exposed but the scales are imbricated, not separated by actual gaps as in *nevadensis*.

A paratype (U.S.N.M. No. 16884) is represented almost wholly by the head. There are strong teeth on the upper and lower jaws which, along with the broad, strong maxillary, massive mandible, and large size of the species, indicate a predatory type. These teeth are conical, rather thick, and nearly straight or slightly curved toward their tips. The largest tooth in the upper jaw measured 0.9 mm in length, that of the lower jaw 1.0 mm. If the head length (here about 30 mm) was approximately one-third the standard length, this specimen was very similar to the holotype in size.

A third specimen (U.S.N.M. No. 16885), designated as a paratype of *eulepis*, is represented almost wholly by beautifully preserved scales. These are rectangular, rounded at the apex, with 8 to 12 radii and with the focus behind the scale center. The circuli are fine and numerous, 23 to 25 or more. At least one sharp annulus is clear, suggesting that winters were cold when *eulepis* lived. On several particularly well-preserved scales, two annuli are visible, much closer together than the distance from the focus to the first annulus. This indicates that growth was rapid in the first year, and suggests that the decreased growth rate at the end of the first year was correlated with the attainment of maturity.

Other specimens contained on two pieces, Calif. Inst. Tech. No. 10245, from the type locality of *F. curryi*, are referred to *eulepis*. These fish, of which half are on the one piece and half on the other (Figs. 3 and 4), are too slender to be assigned to *curryi*. The largest one has the dorsal fin well in advance of the anal, with about 13 rays; the anal has 13 or 14 rays, of which the posteriormost are elongated. The anal base is 1.7 in the length of the peduncle; the peduncle is slightly more than twice as long as deep. The depth of the body at the dorsal fin is only 1.7 in the length of the peduncle. In *curryi*, the depth of the body at this point is much greater than the length of the peduncle. It is not known whether the formation containing this species and *curryi* is contemporaneous with that containing *eulepis*, but since the slender form coexistent with *curryi* appears to be indistinguishable from *eulepis*, it seems best to tentatively refer it to *eulepis*.

Etymology.—The name *eulepis*, meaning well-scaled, refers to the close-set, numerous scales found on the holotype.

Fundulus davidae, n. sp.

Types.—The holotype is the specimen represented by the right and left halves of the two pieces of matrix marked California Inst. Tech. no. 10276. It was received by Dr. Lore David from a wildcat oil driller.

Type locality.—Mohave Desert near Black Mountain (U.S.G.S. Searles Lake quadrangle), about 40 miles northwest of Barstow and 25 miles southeast of Johannesburg, northwestern San Bernardino County, Calif. The horizon has not been determined, but the appearance of the matrix suggests that it may be of Pliocene or early Pleistocene age.

Description.—The holotype, and only known specimen, is about 35 mm long. Its two halves represent a nearly complete fish. The dorsal fin is inserted slightly behind the origin of the anal, and has about 11 or 12 rays. The anal fin has 11 or 12 rays. Both of these fins are well behind the midpoint of the body. The pelvics, probably 6-rayed, reach about halfway to the anal origin and are more posterior in position than in the other fossil species. They definitely lie much nearer the caudal base than the tip of the snout. The pectorals are crushed, with 15 or 16 rays. The caudal fin is represented chiefly by impression and probably had as many principal rays (20) as in the previously described fossil species.

The length of the head is about 2.9 in the standard length, and the body depth at the dorsal origin is about 4.0 in this distance. The depth of the caudal peduncle approximately equals its length. The length of the anal base enters the peduncle length 2.3 times and is about 1.3 in the distance forward from anal to pelvic origins. There are approximately 30 vertebrae, 11 precaudal and 19 caudal.

The scales are moderately large and imbricated as in *eulepis* and *curryi*, with a few of the radii occasionally exposed. The circuli are much more numerous than in *nevadensis* but appear to be fewer than in *eulepis*. The scales on the opercle are large, as in many cyprinodonts, numbering about 15 in all. I estimate that there were 45 to 50 in the lateral series, as there probably were in *curryi* and *eulepis*. This is a greater number than in the living species of the Pacific slope (about 30 to 37), but much fewer than in the fine-scaled fossil species, *Fundulus nevadensis*.

A cyprinodont described by Jordan (1924, pp. 45–47, pls. I–J) as *Parafundulus erdisi* from northern Los Angeles County[3] appears, from the figures, to resemble *Fundulus parvipinnis* more closely than it does any of the known fossil species of *Fundulus* except *davidae*. *F. davidae* has a somewhat deeper body and more posterior dorsal and anal fins. The distance from the end of the hypural to the origin of the dorsal fin enters the standard length at least 3.5 times, rather than 2.8 to 3.1 times as measured from the figures of *erdisi*. The base of the anal fin in *davidae* enters the caudal peduncle about 2.3 rather than 1.3 to 1.6 times as in *erdisi*. In that species the dorsal lies in advance of the anal whereas in *davidae* it is behind the anal origin. This difference is not great, however, and may be related to sexual dimorphism. The larger specimen figured by Jordan may be a male, for the anterior rays of the anal fin appear to be elongated as in males of *parvipinnis*.

Jordan (1925, p. 43) pointed out that *Parafundulus* is probably not distinct from *Fundulus* and it is regarded herein as a synonym of *Fundulus*.

[3] No definite age was assigned to these beds in the original account, but Jordan later wrote (1925, p. 43) that the genus *Parafundulus* was probably Pleistocene.

Etymology.—This species is named after Dr. Lore R. David, an eminent student of the fossil fish faunas of California, who recognized it as an undescribed form of *Fundulus*.

Genus **Cyprinodon** Lacépède

Cyprinodon breviradius, n. sp.

Types.—The holotype (Fig. 3) and only known specimen of this species is the individual represented by the right and left halves of the two pieces of matrix labeled No. 10245, Loc. 335, Calif. Inst. Tech. It was collected by H. Donald Curry and is nearly complete except that the head end is missing. However, the shape of the body, the position of the fins, the number of fin rays, and the small size of the hypural all strongly suggest that the fossil is a member of the genus *Cyprinodon*. Unfortunately it cannot be stated whether the teeth were tricuspid.

Horizon and type locality.—The horizon and type locality of *C. breviradius* have been described under the discussion of *Fundulus curryi*.

Description.—The holotype is estimated to have been about 33 mm long. The small fins suggest that it is a female. The dorsal fin, with 10 or 11 rays, is anterior in position as it is in *C. macularius* Baird and Girard, the species now living in the lower Colorado River Basin (Miller, 1943*a*, pp. 12–13, table I, pls. 1, 2). The origin of the dorsal fin lies almost over the origin of the pelvic fins. The anal fin has 10 or 11 rays and originates almost directly below the end of the second third of the base of the dorsal fin. The pelvics, composed of 6 or 7 rays, apparently do not reach more than half the distance to the origin of the anal fin. The pectoral fins are missing, and only the basal part of the caudal fin is present.

The depth of the body at the dorsal origin enters the distance between the insertion of the pelvic fins and the caudal base about 1.5 times. The distance between the last dorsal ray and the end of the hypural approximately equals the body depth. Both the dorsal and anal fins, particularly the anal, appear to have been small, even smaller than in *Cyprinodon salinus* Miller, the Recent species of Salt Creek, Death Valley (Miller, 1943*b*, pl. 1).

There are about 20 caudal vertebrae, which is a greater number than in most of the living species of the region.

Cyprinodon breviradius resembles *C. macularius* in the position of the dorsal and pelvic fins, but is more slender-bodied. In that feature it is similar to *C. salinus*.

Etymology.—The name *breviradius*, meaning short-rayed, refers to the short rays of the dorsal and anal fins.

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BOTANY.—*Two new species of* Scleria *from the Upper Amazon Valley.*[1] EARL L. CORE, West Virginia University. (Communicated by E. P. KILLIP.)

Among specimens of *Scleria* recently collected by J. T. Baldwin in the state of Amazonas, Brazil, and by José Cuatrecasas in the commissaries of Vaupés and Caquetá, Colombia, were the following two new species. Types are in the U. S. National Herbarium.

Scleria scandens, n. sp.

Culmo alto scandente, acute triquetro, retrorsim scaberrimo, 5 mm crasso; foliis 5–8 mm latis, rigidis, glabris, costa subtus et marginibus retrorsim scabris; vaginis exalatis, pilosis, ligula brevissima, rigida; paniculis numerosis, purpurascentibus, pedunculis gracilibus; spiculis numerosis; squamis glabris; hypogynio stipitiforme, 1 mm longo, quam achenio angustiore, apice trilobo, lobis rotundatis; achenio albo vel purpureo-maculato, 1 mm longo, 2 mm lato, glabro, apice truncato umbonato.

Rhizome not seen; culms climbing, several feet long, 5 mm thick, sharply triquetrous, retrorsely scabrous, leaves numerous, 5–8 mm wide, rigid, glabrous, the midrib beneath and the margins very retrorsely scabrous; sheaths wingless, pilose; ligule short, rigid; panicles numerous, axillary and terminal, purplish, the peduncles slender, flattened; spikelets numerous in each group; scales purple, glabrous or nearly so; hypogynium stipelike, 1 mm long, narrower than the achene, 3-lobed at the apex, the lobes rounded; achene white, purplish black where exposed, 1 mm high, 2 mm broad, essentially glabrous, the apex truncate, umbonate.

BRAZIL: Ilha Nova Vida, upper Rio Negro, Amazonas, February 12, 1944. *Baldwin* 3285, Type in U. S. National Herbarium.

This species is closely related to *S. splitgerberiana* Henrard, of Surinam, but differs in its more robust habit, larger panicles, and smaller, glabrous achenes.

Scleria grandis, n. sp.

Rhizomate ligneo, squamis atro-rubris intecto; culmo 1–2 m alto, triquetro; foliis 5 dm longis, 18–45 mm latis, in marginibus scabris; vaginis ampliatis, alatis; ligula abbreviata, rotundata, rigida; panicula terminali, solitaria, densa, conica, straminea, 5–15 cm longa; bracteis foliaceis, 20 cm longis; spiculis masculis longe pedicellatis, numerosis; spiculis foemineis paucis, in ramorum basi subsessilibus; squamis masculis anguste mucronatis; squamis foemineis ovato-lanceolatis; hypogynio trilobo, lobis ovatis; achenio 3 mm longo laevi triangulari, albo vel interdum griseo, hirtello. *Scleriae cyperinae* proxime affinis.

Rhizome thick, hard, covered with red-brown scales; culms 1–2 meters tall, robust, sharply triangular; leaves about 5 dm long, 18–45 mm wide, somewhat scabrous on the margins and midrib beneath; sheaths winged, often conspicuously so, the wing-margins slightly scabrous; ligule rotund, the margins rigid, without an appendage; inflorescence solitary, terminal, conic, dense, straw-colored, 5–15 cm long; bracts foliaceous, mostly 3, 20 cm long or longer, 18–35 mm wide; bractlets filiform, minute; staminate spikelets long-pedicelled, linear, very numerous; pistillate spikelets subsessile, few; staminate scales narrow, straw-colored or purplish-tinged, the upper long-mucronate, the lower acute; pistillate scales ovate-lanceolate, glabrous, stramineous or purplish-tinged, hypogynium 3-lobed, the lobes ovate; achene 3 mm long, shorter than the scales, not tuberculate or rugulose, ovoid, sharply trigonous, white or discolored, minutely white-pubescent.

COLOMBIA: Selva del Tui-Igarape, 200 m alt., cerca de Mitu, Vaupés, September 17, 1939, *Cuatrecasas* 6870. Type in U. S. National Herbarium, nos. 1795819, 1795820. Cerro de La Sardina, 500 m alt., bosque, Florencia, Caquetá, March 30, 1940, *Cuatrecasas* 8890.

BRAZIL: Santa Isabel, Rio Negro, Amazonas, February 15–16, 1944, *Baldwin* 3421.

This very distinctive species, a member of the section *Hymenolytrum*, is clearly distinguished from its nearest relative, *S. cyperina*, by its more robust habit, its much broader leaves, and its smooth achenes. *S. grandis* and *S. cyperina* are the only known members of the section lacking the large, conspicuous, scarious appendage to the ligule found in *S. stipularis*, *S. ramosa*, *S. violacea*, *S. macrogyne*, *S. comosa*, and *S. cyperinoides*.

[1] Contribution No. 34 from the Herbarium of West Virginia University. Received July 5, 1945.

ENTOMOLOGY.—*Six new species of beetles of a eumolpid genus new to the West Indies.*[1] Doris H. Blake. (Communicated by S. F. Blake.)

The genus *Alethaxius* (Coleoptera: Eumolpidae), under which I herein tentatively place six new West Indian species, was originally described by Chapuis[2] as *Aletes*, a preoccupied name later changed by Lefèvre[3] to *Alethaxius*. These West Indian species do not entirely correspond with Chapuis's description drawn up from a single species from Colombia but seem closer to four species later described by Lefèvre,[4] also from Colombia. According to Chapuis, *Aletes* (=*Alethaxius*) is closely related to *Colaspis*, but in *Aletes* the antennae are somewhat more compressed (in the West Indian group the distal joints are shorter and thicker), the eyes are more developed (in the West Indian species the eyes are very prominent), and the form of the pronotum is different (in the West Indian group the prothorax is large, the sides varying from undulate and even prominently toothed to simply arcuate and entire). Moreover, in both West Indian species and those described by Lefèvre there is a marked difference between the sexes, the females having a peculiar elytral development in the form of nodules or ridges below the humeri. In another respect some of the West Indian species resemble two species later described by Lefèvre, i.e., the femora are toothed. In Lefèvre's species the posterior femora alone are described as toothed. This character appears to be a variable one, since while the teeth are prominent on all femora in three of the West Indian species, in one they are only weakly developed and in another appear only in the posterior femora. In one species the teeth are entirely lacking. Since Lefèvre, Jacoby has contributed most of the remaining species to the genus, describing numerous Central and South American species that more or less doubtfully he has assigned to *Alethaxius*. Bowditch has added three from South America. The present group may eventually prove too distinct to be included in this genus. It appears to be common to the West Indies, occurring so far as is already known in Cuba, Puerto Rico, and Hispaniola, and is singularly constant in general characteristics. In fact, the males of a species collected on the summit of Pico Turquino in eastern Cuba are not readily distinguishable from the males of two species found in the mountains of central Dominican Republic except by their quite different genitalia. The females, on the other hand, have distinctly different elytral nodulation. The females are so unlike the males in this group that it is probable that future entomologists may describe each as specifically distinct unless the sexes are collected together.

[1] Received April 30, 1945.
[2] *Genera des coléoptères* . . . **10**: 250–251. 1874.
[3] *Eumolpidarum . . . Catalogus.* Mem. Soc. Liege, ser. 2, **11**(16): 42. 1885.
[4] Mitth. Münchener Ent. Ver. **2**: 124–126. 1878.

Alethaxius hispaniolae, n. sp.

Fig. 1

Female about 4 mm long, robust, dark bronze shining with aeneous or coppery lights, legs, mouthparts, and undersurface reddish brown, basal joints of antennae pale, apices of last five joints dark; densely punctate; prothorax with undulate or obtusely toothed margin; elytra with small raised tubercles below the humeri; femora sharply toothed.

Male about 3.3 mm long, above bright shining green, elytra entirely lacking tubercles.

Head with prominent, widely separated eyes; a tumidity about base of antennal sockets; median area on vertex polished and with a slightly impressed line, from this area radiating lines of punctures producing a wrinkled effect over occiput and about eyes. Antennae extending below humeri, first two joints swollen, 3–6 slender, 7–11 thickened and with dark apices. Prothorax a third wider than long, densely punctate except in middle along the anterior margin, the punctures appearing coarser and more crowded on sides, lateral margin obtusely bitoothed, in some specimens almost undulate, an acute tooth at anterior and posterior angles, and a slight depression across the anterior part of disk over the occiput of head. Elytra in female densely and along sides

in basal half even rugosely punctate, with a group of raised warts or tubercles extending down from the humerus, gradually diminishing toward the middle, these rugosities varying in degree in various individuals. Humeri capped with an additional swelling. Punctures in basal half of elytra dense and confused, in apical half the punctures at first with a suggestion of geminate arrangement gradually straightening out into striate, single-lined punctation, finer and not so dense as in basal half. In the male the rugosities and tubercles entirely lacking and the punctation more regular. Body beneath reddish brown, finely pubescent, coxae well separated, anterior coxal cavities closed; prosternum not produced to conceal lower part of head but concave; legs with all the femora prominently and sharply toothed, punctate towards the apex; claws appendiculate. Length 3.9–4.3 mm in female: 3.3–3.4 mm in male; width 2–2.2 mm in female; 1.6 mm in male.

Type material.—Type male and 9 paratypes (7 female, 2 male), Museum of Comparative Zoology No. 27330; a pair in the U. S. National Museum, No. 57298.

Type locality.—Loma Vieja, ca. 6,000 feet altitude, south of Constanza, Dominican Republic, collected in August 1938 by P. J. Darlington, Jr.

Alethaxius darlingtoni, n. sp.

Fig. 6

Female 3–4 mm in length, elongate oblong, shining bronze with greenish luster above and with reddish brown antennae having the apices of distal joints darker, pale mouthparts, legs, and undersurface; densely punctate, prothorax with a smooth area in lower corner and with undulate margin; elytra with numerous tubercles on sides and more finely punctate toward apex; all femora with a prominent tooth.

Male 2.8–3.5 mm long, more greenish in luster, elytra without tubercles.

Head with prominent, nearly entire, widely separated eyes, interocular space more than half width of head, area about antennal sockets swollen, otherwise the front flat and broad, the central part being smoothly polished with radiating lines of punctures going up occiput and about eyes; mouthparts paler and heavy. Antennae at least half the length of body, longer in male, first two joints swollen, 3–6 slender and entirely pale, 7–11 thickened, the apices usually darker. Prothorax not twice as wide as long, with lateral margin undulate, an acute tooth at anterior and posterior angles, disk with a depression anteriorly, densely and coarsely punctate except near middle of anterior margin and near the sides at base, the punctures coarser and more crowded on sides. Elytra in female with many nodules along the sides, extending from the humeri to apical narrowing; at base punctures coarse, dense and confused; from the middle, striate, at first geminate, then in a single line to the apex and much finer. In male, no trace of tubercles, but as in female the humeri conspicuously swollen, the basal punctation coarse but not so dense as in female, and finely striate in apical half; not so costate toward apex as in other species. Body beneath deep reddish brown, legs paler, finely pubescent, all femora conspicuously toothed; tibiae grooved, first tarsal joint not much longer than second. Length of female 3.2–4.2 mm, width 1.6–1.9 mm. Length of male 2.8–3.5 mm, width 1.4–1.7 mm.

Type material.—Type male and 16 male and 17 female paratypes, Museum of Comparative Zoology No. 27331; a pair in the U. S. National Museum, No. 57299.

Type locality.—Loma Rucilla and mountains north, 5,000–8,000 feet altitude, Dominican Republic, collected in June 1938 by P. J. Darlington, Jr.

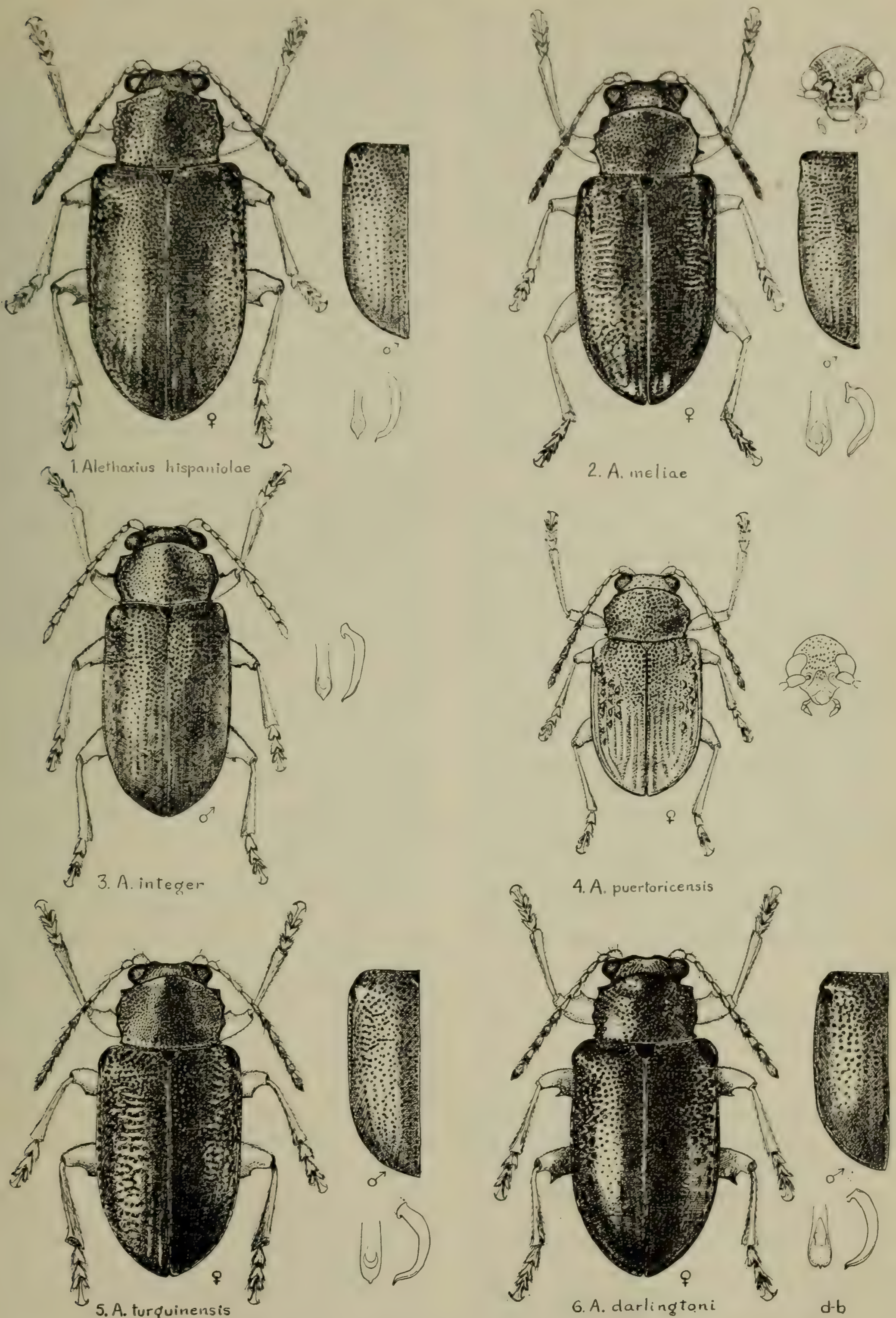
Remarks.—This species bears a close resemblance to *A. hispaniolae.* There are, however, on the elytra more nodules which extend farther down on the sides, and the prothorax has a smooth impunctate area on the sides. The male genitalia are quite unlike those of *A. hispaniolae.*

Alethaxius integer, n. sp.

Fig. 3

No females examined. Male 3 mm in length, oblong-oval, shining aeneous with pale yellow-brown antennae, legs, and undersurface, densely punctate, prothorax with rounded sides, all femora toothed.

Head with interocular space more than half width of head, polished, rather finely and not so densely punctate as in other species, a double row of punctures above the swollen areas around antennal sockets, a short median line on vertex, lower front mostly impunctate, and



Figs. 1–6.—New species of *Alethaxius* from the West Indies.

losing its aeneous luster; eyes nearly entire and prominent. Antennae yellow-brown, not more than half the length of body, first two joints swollen, 3–6 slender, 7–11 thickened. Prothorax not twice as wide as long, moderately densely punctate, the punctures on sides becoming coarser, explanate margin not undulate or angulate with no suggestion of median toothing, but rounded, a tooth at the basal angle. Elytra more coarsely punctate than pronotum, punctures very dense in basal half and somewhat coarser below humeri, in apical half becoming striate. Body beneath paler with light pubescence; femora all toothed, tibiae channeled, first tarsal joint not much longer than second, claws appendiculate. Length 3 mm; width 1.6 mm.

Type.—Male, Museum of Comparative Zoology No. 27332.

Type locality.—Mount Diego de Ocampo, Dominican Republic, 3,000–4,000 feet altitude, collected in July 1938 by P. J. Darlington, Jr.

Remarks.—I have examined only one specimen, a male, but have little doubt that the female will prove to be larger and probably with nodules or ridges along the sides. These are indicated in the male by the coarser, denser punctures in that area. Unlike any of the rest of the species here described, the prothorax has no sign of toothing or angularity but is simply arcuate. This exception to the general rule so far observed in the genus is proof that the toothing of the thorax as well as of the femora is a variable character. Otherwise the species is closely related to the two already described from the Dominican Republic. The aedeagus bears a strong resemblance to that of *A. hispaniolae.*

Alethaxius turquinensis, n. sp.

Fig. 5

Female 3.5–4 mm in length, bronzy or coppery with faint green or purple luster, mouthparts, antennae, legs, and undersurface pale reddish or yellowish brown; densely punctate, margin of prothorax undulate, elytra rugose, usually with raised tubercles along sides and at the apex costae between the striate punctation.

Male 3–4 mm in length, more brightly aeneous or purplish, elytra less rugose, lacking tubercles.

Head with interocular space half the width of head, eyes prominent, almost entire, area about antennal sockets swollen, front otherwise flat and broad with fewer punctures than on top and sides, the punctures becoming striate. Antennae at least half the length of body, basal joints paler, apices of distal joints tending to be dark, distal joints thickened. Prothorax about a third wider than long with undulate and sometimes angulate lateral margin, usually with two undulations and an acute tooth at anterior and posterior angle; punctation fine and very dense except along anterior and posterior margins. Elytra in female rugose with irregular transverse ridges, on outer half below the humeri elevated to form warty tubercles in many specimens, punctation denser and coarser than on pronotum, and toward apex becoming striate, the intervals between somewhat costate; humeri polished and prominent; in the male the elytra not so rugose but still with a suggestion of transverse ridging. Body beneath yellowish or reddish brown, lightly pubescent, a small but distinct tooth on all femora. Length, female, 3.6–4.3 mm; width 1.8–2.1 mm. Length, male, 2.9–4.1 mm; width 1.6–2 mm.

Type material.—Type male and 19 paratypes (12 male and 7 female), Museum of Comparative Zoology No. 27333; a pair in U. S. National Museum, No. 57300.

Type locality.—Pico Turquino, 5,000–6,000 feet altitude, collected by P. J. Darlington, Jr., in June 1936.

Remarks.—If we do not consider the tubercles in the females, this species is the most rugose of any of the West Indian group; likewise it is the dullest, the specimens showing little of the shining aeneous-green of the others, even in the males which are only slightly more lustrous. The punctures on the prothorax are the densest and finest found in any of the species.

Alethaxius meliae, n. sp.

Fig. 2

Female about 3.5 mm in length, elongate oblong, shining green or coppery, legs, some of undersurface, and six basal antennal joints pale yellow-brown, distal joints dark; densely punctate above; prothorax with two distinct median teeth on margin; elytra with a short

ridging or nodules below humeri and swollen costae at apex. Hind femora weakly toothed.

Male 3–3.5 mm in length, lacking ridges or nodules below humeri, the apical costation not so developed.

Head with prominent, widely separated eyes, interocular space a little more than half the width of head, eyes very little emarginate; area about antennal sockets swollen, otherwise the front flat, a short median line on vertex, this median space less punctate than about eyes and on occiput, the punctation becoming somewhat striate about eyes. Mouthparts pale brownish. Antennae at least half length of body in male, shorter in female; distal joints thickened and dark. Prothorax a third or less wider than long, densely punctate, the punctures on the sides becoming coarser, a little depression below anterior margin; sides with two acute teeth between the acute tooth on anterior and posterior angles. Elytra densely punctate in basal half, and finer and less densely in apical half, towards apex becoming striate with the interstices costate at apex, particularly swollen at the tip in the female and forming an apical tumidity; in the single female specimen examined a broken ridge or series of nodules running down below the humerus a short distance, this nodulation entirely lacking in male. Body beneath reddish or yellowish brown, with the sides of the prosternum and metasternum aeneous, the latter punctate; legs pale with punctures on femora becoming coarser and more apparent at apex; a distinct tooth on posterior femora; tibiae grooved. Length, female 3.6 mm; width 1.7 mm; length, male 3–3.5 mm; width 1.3–1.4 mm.

Type material.—Type male and 11 male and 1 female paratypes, U. S. National Museum No. 57301; 2 male paratypes in Museum of Comparative Zoology.

Type locality.—Villalba, Puerto Rico, collected on *Melia* sp. by R. G. Oakley, June 18, 1934.

Remarks.—This is the slenderest and the most densely punctate of the group from the West Indies. It is the only one with sharply produced teeth on the prothorax. The single female examined had only a short broken ridge or tubercles, not very conspicuous, on the elytra. Only the posterior femora are toothed. It is the most golden-green of the species here described and very lustrous.

Alethaxius puertoricensis, n. sp.

Fig. 4

Female between 2.5–3 mm in length, oval, shining, yellow-brown, the distal joints of antennae and undersurface deep reddish brown; densely and coarsely punctate, the punctures of the elytra more or less striate, the interstices being somewhat costate, and on the sides several rows of warty elevations along costae, the humeri unusually prominent; thorax acutely angulate; femora not toothed.

Male unknown.

Head polished with numerous but not dense punctures, a line of them slightly above antennal sockets; interantennal area smooth, broad; front with a faint median vertical line; eyes widely separate, interocular space half width of head. Antennae reaching the middle of the elytra, first two joints swollen, 3–6 slender, 7–11 thickened and with darkened apices. Prothorax not twice as broad as long, depressed below the middle, margin with almost toothed angles near the middle, and a distinct basal tooth; disk densely and coarsely punctate. Elytra tending to be costate between the rows of punctures, the punctures at base somewhat confused, possibly geminate, becoming single striae at middle, on the sides the costae becoming warty, 4 or 5 rows of warts, and an enlarged hump on the humerus. Body beneath deep reddish brown, shining, lightly pubescent. Legs paler, femora not toothed, tibiae grooved on one side; first tarsal joint not much longer than second, claws appendiculate. Length 2.6–2.9 mm.; width 1.4 mm.

Type material.—Type female, Museum of Comparative Zoology No. 27334; 1 paratype, a female, in U. S. National Museum, No. 57302.

Type locality.—El Yunque, ca. 3,000 feet altitude, Puerto Rico, collected in May 1938 by P. J. Darlington, Jr.

Remarks.—This species is unlike the others described in this paper in coloration, being simply yellow-brown without any metallic luster, in being much smaller in size, and in lacking altogether any toothing of the femora. The general aspect of the head is unlike the rest. There are no swollen areas about the antennal sockets; the front of the face is smoother and not so punctate. Furthermore, the antennae are longer. In the pattern of its elytral punctation and wartiness it is very similar to the rest. Unfortunately, no male has been examined.

ENTOMOLOGY.—*A new larvaevorid parasite of the social butterfly* Eucheira socialis *Westwood (Diptera)*.[1] MAURICE T. JAMES, U. S. Bureau of Entomology and Plant Quarantine.

The larvaevorid described in this paper was submitted to me for identification by A. C. Baker, of the Mexico City laboratory of the Bureau of Entomology and Plant Quarantine. Being unable to place it as to genus, I requested that specimens be sent to H. J. Reinhard, of the Texas Agricultural Experiment Station, who, in turn, referred one of them to A. R. Brooks of the Department of Agriculture of Canada. Neither of these workers could do more than to place it in the Ernestiini, near *Mesembrierigone* Townsend, the genus to which it traces in Townsend's keys.[2] Since a name is desired for a report of its host relationships, I am referring it to a new genus and species of Ernestiini.

Eucheirophaga, n. gen.

Head slightly wider than high, its length at base of antennae approximately equal to that at oral margin and about three-fifths head height. Front flat in lateral profile, equal to face in length; vertex one-sixth head width in male, almost one-quarter in female. Face in lateral profile concave, the epistoma being rather strongly though gradually warped forward; clypeus transversely convex, its sides but slightly sunken, its middle distinctly elevated over facials; no facial carina; epistoma transversely convex, fully as broad and half as long as clypeus. Parafacials bare; each facial with several bristles and a few short hairs near vibrissa, otherwise bare. Cheek about one-half to three-fifths eye height. Eyes thickly and uniformly long-pilose. Antenna reaching to upper margin of epistoma; first segment short, porrect; second moderately long; third $1\frac{1}{2}$ length of second and rather broad; arista bare, its first two segments each twice as long as thick, its third segment thickened on basal half, thence tapering to a sharp point. Palpi well developed, clavate, reaching to or beyond epistoma; proboscis short, labella fleshy. Outer verticals well differentiated in female, poorly so or not at all in male; inner verticals strong, cruciate; postverticals small; ocellars small, weaker than frontals, proclinate; frontals strong, extending 3 to 5 on each side below antennal base but not extending below base of arista; frontoorbitals 2 strong proclinate and 2 strong reclinate in female, none in male; gnathoorbitals 3 to 4 on each side.

Transverse suture distinct, dividing mesonotum into two approximately equal parts. Prosternum fine-haired laterally; propleura bare; no infrasquamal setulae. Acrosticals 3–3, hind presutural pair very close to suture; dorsocentrals 3–3; intraalars 1–3; supraalars 1–3; sternopleurals 3, almost in a row; pteropleural 1, strong, reaching practically to apex of squama; lateroscutellars 3, strong; no apicoscutellar; discoscutellars 1 strong pair and 2 or 3 weaker pairs. Legs not elongated; tarsi subequal in length to tibiae. Wings slender, rather pointed, especially in male; apical cell open and ending a distance equal to length of r-m before wing tip; cubitulus rectangular, with a very short stump; last section of vein Cu_1 about one-fifth previous section; veins R_1 and Cu_1 bare; vein R_s with about 3 to 5 setulae at its base. Squamae bare above.

Abdomen ovate, nearly as deep as wide, with four pregenital segments; genitalia apicoventral, not concealed in a slit. Marginals lacking on segment 1; a strong median pair, extended laterally into a weak row, on segment 2; strong marginal rows each on segments 3 and 4; segments 2 to 4 each with 2 median discal pairs arranged one in front of the other, and with several unpaired weaker bristles or strong bristlelike setulae at each side of the median series; on segment 4, because of the narrowness of the segment, these bristles may appear to be arranged in rather a haphazard fashion. Sternates of pregenital segments almost wholly concealed.

Genotype, *Eucheirophaga lugubris*, n. sp.

In Curran's key,[3] *Eucheirophaga* will trace to *Hineomyia* Townsend, couplet 208 (p. 444), but in that genus, among other differences, the

[1] Received June 20, 1945.

[2] TOWNSEND, C. H. T., *Manual of myiology*, pt. 3: 8–15, 20–27, 205–206, 1936, Itaquaquecetuba, São Paulo, Brazil. In order to make this genus (and *Mesembrierigone* as well) run through the tribal key, pp. 20–27, the word "or" must be inserted between the two parts of the second alternative of couplet 4.

[3] CURRAN, C. H. *The families and genera of North American Diptera*, 512 pp. New York, 1934.

face is distinctly receding, the epistoma is short, the third antennal segment is sharply truncated apically, only two presutural acrosticals, the hind one remote from the suture, are present, vein M_2 is continued far beyond the cubitulus, and the sternites (at least in the female) are broadly exposed and bristled. The closest relationship of *Eucheirophaga* to any known genus is probably to *Mesembrierigone*, but in that genus, among other differences, the basal two aristal segments are each but little longer than wide, the third antennal segment is twice as long as the second, the ocellars are strong, cruciate apicoscutellars are present, the second and third abdominal segments have each but one pair of median discals, and the cubitulus is bent to an acute angle without a stump.

Eucheirophaga lugubris, n. sp.

Male.—Predominantly black and black-haired, with a yellow face and with cinereous-pollinose areas on the abdomen. Relative head measurements in micrometer units (from holotype): Head width, 65; head height, 62; vertex, 11; length of head at base of antenna, 36, at oral margin, 35; length of front, 37, of face, 37; cheek width, 20; eye height, 40; minimum width of parafacial, 8; maximum width of facial, 6; width of epistoma at vibrissa, 16; maximum width of clypeus, 17; length of first, second, and third antennal segments and arista, 3, 11, 16, 24, respectively. Corneous part of haustellum about one-third head height.

Frontalia brown; parafrontals and occiput black; face yellow; antenna black, extreme apex of second and base of third segment reddish; arista blackish, tending to become brownish on the thickened part; proboscis brown; palpi black. Head covered with yellowish pollen, thickly so on lower parts of occiput and face, thinly so on parafrontals. Pile of occiput and lower parts of cheeks bushy yellow; that of eyes yellow; that of head otherwise black. Thorax and legs, including all hairs and bristles, black; mesonotum lightly cinereous-pollinose, with four longitudinal vittae of brownish pollen; scutellum with brownish pollen which becomes cinereous apically. Pleura with scant cinereous pollen. Squamae infuscated. Wings grayish subhyaline, the veins except on the apex and posterior third of the wing broadly bordered with fuscous, the clouding tending to run together so that a large part of the anterior basal half or more of the wing is infuscated. Abdomen, including its hairs and bristles, black; dorsal surface of tergites thinly brownish-pollinose with a prominent transverse lateral cinereous marking on each side of the second,

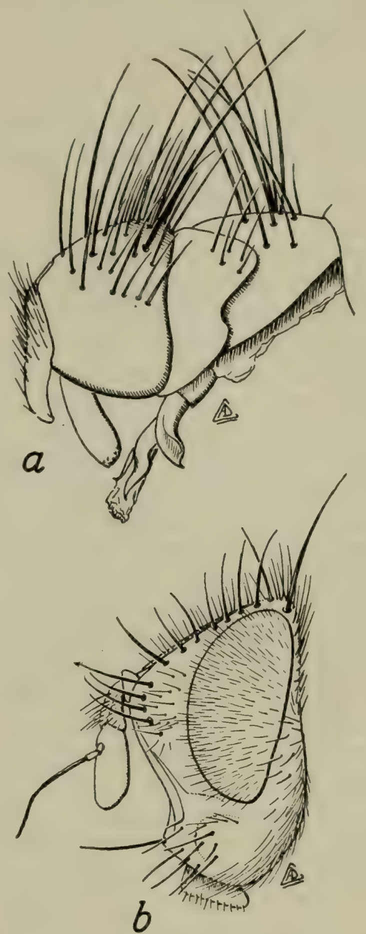


Fig. 1.—*Eucheirophaga lugubris*, n. sp., male: *a*, Genitalia; *b*, side view of head. Drawings by Arthur Cushman.

third, and fourth segments, these markings appearing conspicuous from a posterior view; sides and ventral surface of fourth segment largely cinereous-pollinose.

Genitalia blackish dorsally, becoming reddish ventrally. Anal forceps united, beaklike, rather small, broad basally and tapering to a blunt point; outer clasper twice as long as wide, parallel-sided for most of its length, the apical margin oblique and ending in an angle of about

60°; inner clasper slender, bladelike, arcuate with a small hook at the apex; penis simple, tubular.

Female.—Differs in sexual characters and in those indicated in the generic description.

Holotype.—Male, U.S.N.M. no. 57286, 63 km from Mexico City in the State of Morelos, January 1944 (J. G. Shaw), from *Eucheira socialis* Westwood, on *Arbutus* sp., Shaw no. 5047.

Described also from the allotype, female, and paratypes, 1 male and 1 female, same data, and from a series of specimens, mostly in poor condition, only 1 male and 1 female being considered paratypes, from Morelos, Mexico, February 1944 (J. G. Shaw), from *Eucheira socialis* on *Arbutus* sp., Shaw no. 5049.

ICHTHYOLOGY.—*The leatherjackets, carangid fishes of the genus* Oligoplites *Gill, inhabiting American waters.*[1] LEONARD P. SCHULTZ, United States National Museum.

This study was undertaken in an attempt to determine the valid scientific name for the leatherjacket, or palometa, inhabiting the brackish and fresh waters of Lago de Maracaibo, Venezuela, and also to try to straighten out some of the confusion centering around the other species of the Western Atlantic Ocean. I have examined nearly all the specimens of this genus in the U. S. National Museum, and they form the basis for my conclusions. Although not all the records in the literature are included in the synonymy for each species, most of the important ones are listed except for *saurus* along the Atlantic coast of the United States, where it is not confused with any related species. I do not see how one is justified in recognizing the subgenus *Leptooligoplites* Fowler (Acad. Nat. Sci. Philadelphia Monogr. 6: 223. 1944; genotype, *Oligoplites refulgens* Gilbert and Starks) on the basis of a few more gill rakers and elongate form. The differences in dental structures would be a much better characteristic on which to establish subgenera if such were needed, but I do not think it necessary in this otherwise distinct group.

Dr. T. Gill (Proc. Acad. Nat. Sci. Philadelphia, 1863: 166) proposed the genus *Oligoplites* with *Oligoplites inornatus* Gill as genotype, thus separating the Eastern Atlantic and African species with a few more dorsal spines from related species in American waters. The genus is easily recognized by the "mackerel form" of the compressed body; the two free anal spines at the front of the anal fin; lunate-shaped caudal fin; long anal and dorsal fin with all of the soft rays connected by membrane so that no free finlets occur; skin without external scales, although covered with fine ridges, representing minute embedded scales that extend at slightly different angles; lateral line unarmed, running along the middle or lengthwise axis of the body, and a little arched over the pectoral fin; dorsal profile anteriorly with a low keel; head short, compressed, somewhat pointed; the greatest depth of body near origin of second dorsal; mouth oblique, large, the lower jaw projecting slightly; premaxillaries not protractile, the premaxillary groove not continuous across tip of snout; maxillary narrow, long, reaching to under rear of orbit or past it, without supplemental bone; teeth present on premaxillaries, vomer, palatines, dentary and tongue; those on dentary in the young and half grown with an outer row that flares outward, curving dorsally so that the band of teeth in the upper jaw fits into the trough made by these numerous curved teeth, but these appear to be lost so that the adult has a row of much less closely spaced teeth that are less curved and coarser; gill rakers long; dorsal spines usually IV or V, rarely III or VI, connected at base by a low membrane; anterior rays of soft dorsal and anal fins somewhat elevated anteriorly, but with deep notches between the rays posteriorly; pectoral fins short; gill membranes extending far forward with a small delicate membrane connecting across the isthmus anteriorly; pelvics fitting into a groove, in-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received July 16, 1945.

serted under the pectoral fin bases.

Numerous counts were made on the various species studied and these are recorded in Table 1.

KEY TO THE SPECIES OF OLIGOPLITES

1a. Number of gill rakers, including rudiments, on first gill arch, 5 to 7 + 1 + 16 to 21; dorsal surface of head without a network of tubes opening through numerous pores on surface of skin; mucous pores however, appear to develop more numerously on adults with increase in size.

2a. Premaxillary with a single row of short conical teeth along its entire length, except in young about 85 mm and shorter this row irregular or nearly in 2 rows anteriorly at front of snout; toothed portion of vomer a patch, usually a trifle longer than wide and somewhat bluntly pointed posteriorly; teeth on dentary in 2 distinct rows; dorsal rays IV–I, 20 or 21; depth 3 to 3.4; head 1.3 in young, 1.4 to 1.6 in adults; posterior margin of maxillary more or less truncate; Central America and West Indies to Montevideo, Uruguay.........*Oligoplites saliens* (Bloch)

2b. Premaxillary teeth (65 mm in standard length and shorter) in 1 or 2 rows posteriorly, becoming a narrow band anteriorly; toothed portion of vomer much longer than wide, with a short, somewhat pointed, posterior projection; teeth on dentary in 2 rows; dorsal rays usually V-I, 19 to 21, rarely IV spines; depth 3.9 to 4.6; head 0.85 to 1.0; posterior part of maxillary angularly rounded; Pacific Ocean from Panama Bay to Guayaquil, Ecuador.
Oligoplites refulgens Gilbert and Starks

1b. Number of gill rakers, including rudiments, on first gill arch 3 to 6 + 1 + 10 to 15.

3a. Dorsal surface of head without an underlying network of tubes, opening to surface through numerous pores.

4a. Premaxillary with a band of villiform teeth along its entire length, posteriorly narrow, but anteriorly wide, consisting of several rows; toothed portion of vomer usually a little longer than wide, more or less pointed posteriorly; teeth on dentary becoming a band anteriorly; dorsal rays IV-I, 19 to 21, rarely V free spines; depth 3.4 to 3.8; head in greatest depth 1.2 to 1.4; posterior tip of maxillary rounded, reaching past orbits in adults; Nicaragua to Rio de Janeiro, Brazil, in Lake Yzabal, Guatemala, and in Lake Maracaibo, Venezuela.
Oligoplites palometa (Cuvier and Valenciennes)

4b. Premaxillary teeth essentially in 2 distinct rows along its entire length except far posteriorly where it may become an irregular row, and far anteriorly near tip of snout where a minute row of teeth may occur between the two distinct rows; toothed portions of vomer on half-grown and adults much longer than wide, posterior projection more or less tapering to a point behind; teeth on dentary in 2 rows; dorsal rays V-I, 18 to 21, rarely IV or VI free spines; depth 3.4 to 4.1; head in greatest depth 1.0 to 1.6; posterior edge of maxillary rounded, usually not reaching past orbit.

5a. Premaxillary with 2 distinct rows of teeth, seldom with a few minute ones between them far anteriorly; gill rakers on lower limb of first arch usually 13 or 14 (11 to 14), counting rudiments; Woods Hole, Mass., southward in Gulf of Mexico and West Indies to Montevideo, Uruguay.
Oligoplites saurus saurus (Bloch)

5b. Premaxillary with 2 distinct rows of teeth and usually with some minute teeth between them anteriorly; gill rakers on lower limb of first arch usually 14 or 15 (13 to 16), counting rudiments; southern California and Gulf of California to Bay of Sta. Elena, Ecuador.
Oligoplites saurus inornatus Gill

3b. Dorsal surface of head with a network of tubes in skin opening to surface through numerous pores, these best developed in adults, scarcely so in young; premaxillary with a band of teeth, wider anteriorly, outer and inner rows a little enlarged; dentary with some teeth anteriorly between two outer rows; gill rakers 3 to 5 + 1 + 10 to 12; anal rays II-I, 19 to 21; greatest depth 2.7 to 3.2 in standard length.

6a. Tip of snout to rear edge of maxillary 1.7 to 1.8 in head, the latter 4.2 to 4.3 in standard length; length of pectoral fin a little longer than length of maxillaries; Panama to Guayaquil, Ecuador . . .*Oligoplites altus* (Günther)

6b. Tip of snout to rear edge of maxillary 1.4 to 1.6 in head, the latter 3.7 to 4.0 in standard length; pectoral fin a little shorter than length of maxillaries; Gulf of California to Callao, Peru.
Oligoplites mundus Jordan and Starks

Oligoplites saliens (Bloch)

Scomber saliens Bloch, Ichthyologie, Histoire naturelle des poissons **10**: 41, pl. 335. 1792 (Antilles).—Cuvier and Valenciennes, Histoire

TABLE 1.—COUNTS MADE ON VARIOUS SPECIES OF OLIGOPLITES

Species and localities	Dorsal rays							Anal rays			Number of gill rakers on first gill arch																	
											Above angle					At angle	Below angle											
	IV	V	VI	I, 18	I, 19	I, 20	I, 21	II–I, 19	II–I, 20	II–I, 21	3	4	5	6	7	1	10	11	12	13	14	15	16	17	18	19	20	21
saliens:																												
Central America and Gulf of Venezuela	3	—	—	—	—	2	1	—	—	3	—	—	2	2	—	4	—	—	—	—	—	—	1	1	1	1	—	—
Trinidad	1	—	—	—	—	1	—	—	1	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	1	—	—	—
Brazil	3	—	—	—	—	3	—	—	2	1	—	—	—	3	—	3	—	—	—	—	—	—	—	—	3	—	—	—
refulgens:																												
Panama	1	10	—	—	2	6	3	4	3	1	—	—	3	4	2	9	—	—	—	—	—	—	—	1	3	4	2	1
palometa:																												
Central America and Gulf of Venezuela	5	—	—	—	2	3	—	—	4	1	—	2	2	1	—	5	—	—	3	2	—	—	—	—	—	—	—	—
Lake Maracaibo	8	—	—	—	—	5	3	—	5	3	—	—	6	2	—	8	—	—	2	6	—	—	—	—	—	—	—	—
Trinidad	—	1	—	—	—	1	—	—	—	—	—	—	1	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—
Brazil	4	—	—	—	—	3	1	1	2	—	—	—	2	—	—	2	—	—	2	—	—	—	—	—	—	—	—	—
mundus:																												
Mexico	2	1	—	—	1	1	1	—	2	1	—	—	3	—	—	3	—	1	2	—	—	—	—	—	—	—	—	—
Panama	4	1	—	1	4	—	—	2	—	—	1	2	1	—	—	4	1	1	2	—	—	—	—	—	—	—	—	—
Ecuador	3	2	—	2	3	—	—	4	—	—	—	4	—	—	—	4	1	1	2	—	—	—	—	—	—	—	—	—
altus:																												
Panama	—	2	—	—	1	1	—	—	2	—	1	—	1	—	—	2	—	1	1	—	—	—	—	—	—	—	—	—
saurus saurus:																												
Massachusetts to New Jersey	—	7	—	—	4	2	—	3	2	1	—	1	2	—	—	3	—	1	—	2	—	—	—	—	—	—	—	—
Florida	—	14	1	—	2	11	2	2	9	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Texas	—	5	—	—	2	3	—	2	2	—	—	—	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—
Cuba	1	6	—	1	1	5	—	2	4	—	—	—	—	2	—	2	—	—	—	1	1	—	—	—	—	—	—	—
Puerto Rico	—	2	—	—	—	2	—	—	2	—	—	—	5	—	—	5	—	—	—	4	1	—	—	—	—	—	—	—
Jamaica	—	2	—	—	—	2	—	—	2	—	—	—	1	1	—	2	—	—	—	2	—	—	—	—	—	—	—	—
Panama and Colombia	1	9	—	—	2	7	1	—	5	—	—	—	5	—	—	5	—	—	—	3	3	—	—	—	—	—	—	—
Gulf of Venezuela	—	5	—	—	—	4	1	—	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
saurus inornatus:																												
Southern California	—	3	—	—	—	—	—	—	—	—	—	1	2	—	—	3	—	—	—	2	1	—	—	—	—	—	—	—
Mexico	—	11	—	—	5	5	1	7	4	—	—	—	5	7	—	12	—	—	—	—	7	5	—	—	—	—	—	—
Central America	—	11	—	—	1	7	3	1	4	4	—	—	5	8	1	14	—	—	—	—	4	9	1	—	—	—	—	—

naturelle des poissons **8**: 389. 1831 (Martinique; Cayenne; Brazil).

Scombroides saliens Regan, Proc. Zool. Soc. London, 1903, **2**: 66 (Rio de Janeiro).

Scomberoides saltator Lacepède, Histoire naturelle des poissons **2**: pl. 19 (opposite p. 596) upper fig., 1800; *text*, **3**: 55. 1802.

Chorinemus saliens (var. *saliens*) Günther, Catalogue of the fishes in the British Museum **2**: 475. 1860.

Oligoplites saliens Jordan and Evermann, U. S. Nat. Mus. Bull. 47: 899. 1896 (West Indies).—Fowler, Proc. Acad. Nat. Sci. Philadelphia, 1905: 60, fig. 2 (Rio de Janeiro).—Starks, The fishes of the Stanford Expedition to Brazil: 43. 1913 (Pará).—Fowler, Proc. Acad. Nat. Sci. Philadelphia, 1915: 532 (Trinidad); 1919: 129 (Rio de Janeiro).—Ribeiro, Arch. Mus. Nac. Rio de Janeiro **17**: (Carang.) 8. 1915 (Antilles to Rio de Janeiro; Bahía).—Meek and Hildebrand, Marine fishes of Panama, pt. 2: 390. 1925 (West Indies and Brazil).—Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 277. 1930 (West Indies).—Devincenzi, Ann. Mus. Hist. Nat. Montevideo **4** (13): 24, fig. 9. 1939 (Rio de la Plata; Punta Gorda, Montevideo).—Devincenzi and Legrand, Ann. Mus. Hist. Nat. Montevideo, 1940: pl. 5, fig. 2.—Fowler, Proc. Amer. Philos. Soc. **82** (5): 764. 1940 (Rio de Janeiro); Arq. Zool. Est. São Paulo **3**(6): 152. 1941 (Pará, Brazil).

Bloch's description of *saliens* indicates that his specimen had a single row of teeth in the upper jaw (also shown in his figure 335) along with four spines in the first dorsal. On the basis of these two characters I am referring specimens with such a combination of characters to *Oligoplites saliens* (Bloch). In addition, the gill rakers on the lower limb of the first arch of this species are more numerous than on the other species of *Oligoplites* from the Western Atlantic Ocean. They are 16 to 20 instead of 12 to 14.

This is one of the most distinctive species among all those in the genus and can be identified at once by the single row of conical teeth along the premaxillary. The maxillaries in the adults extend past the orbit and form an angle of 40° with the longitudinal axis of the body. The dorsal part of the body is darkish in preserved specimens.

The material examined consists of 7 specimens, all from U. S. National Museum collections, as follows: no. 44701, 1 specimen from the Atlantic coast of Central America; nos. 123073 to 123075, 3 specimens from Gulf of Venezuela; nos. 100824 and 100825, 2 specimens from Porto Inhauma, Brazil; no. 76330, 1 specimen from Rio de Janeiro.

This Atlantic species ranges from Central America, Gulf of Venezuela, and the West Indies southward to Montevideo, Uruguay.

Oligoplites refulgens Gilbert and Starks

Oligoplites refulgens Gilbert and Starks, Mem. California Acad. Sci. **4**: 73, pl. 11, fig. 19. 1904 (Panama Bay).—Meek and Hildebrand, The marine fishes of Panama, pt. 2; 392, pl. 39, fig. 2. 1925 (Pacific coast of Panama to Guayaquil).—Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 278. 1930 (Panama).—Fowler, Acad. Nat. Sci. Philadelphia Monogr. 6: 223, fig. 156. 1944 (Playa Muerto, Panama).

Leptooligoplites Fowler, Acad. Nat. Sci. Philadelphia Monogr. 6: 223, fig. 156. 1944.(Genotype —*Oligoplites refulgens* Gilbert and Starks.)

This species may be recognized by its more slender body and numerous gill rakers on the lower limb of the first arch, 17 to 21 instead of 15 or fewer in the other Pacific species. The maxillaries form an angle of about 32° with the longitudinal axis of the body. I have examined large series of specimens, 75 mm and shorter, from Chame Point, Panama, in U.S.N.M. nos. 81986, 82024, and 82025; also 3 small specimens in U.S.N.M. no. 101745, and 1 specimen, U.S.N.M. no. 101744, both from Colombia.

This Pacific species ranges from Panama Bay to Guayaquil, Ecuador.

Oligoplites palometa (Cuvier and Valenciennes)

Chorinemus palometa Cuvier and Valenciennes, Histoire naturelle des poissons **8**: 392. 1831 (Lake Maracaibo).

? *Chorinemus guaribira* Cuvier and Valenciennes, Histoire naturelle des poissons **8**: 393. 1831 (Brazil).—Günther, Catalogue of the fishes in the British Museum **2**: 475. 1860 (coast of Brazil).

Chorinemus saliens (var. *palometa*) Günther, Catalogue of the fishes in the British Museum **2**: 475. 1860 (Lake Maracaibo).

Oligoplites saliens palometa Jordan and Evermann, U. S. Nat. Mus. Bull. 47: 899. 1896 (Lake Maracaibo, Venezuela).—? Gilbert, Proc. Washington Acad. Sci. **2**: 166. 1900 (Maceio, Brazil).

Oligoplites palometa Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 278. 1930 (Lake Maracaibo).

Scombroides palometa Regan, Proc. Zool. Soc. London, 1903, **2**: 66 (Lake Yzabal); Biologia

Centrali-Americana, Pisces: 15. 1908 (Guatemala, Lake Yzabal; Lago de Maracaibo).
Oligoplites saurus Fowler, Proc. Amer. Philos. Soc. **82**(5): 764. 1940 (? Rio de Janeiro).

This species is the only one known from the Western Atlantic that has a wide band of villiform teeth on each premaxillary. From *O. saurus saurus* of the Atlantic it differs in having IV spines in the first dorsal instead of V. The maxillaries form an angle of about 40° with the longitudinal axis of the body. The dorsal part of its back is blackish. The anterior portion of the second dorsal fin is blackish and the proximal portion of the anterior soft rays of the anal are blackish. The tips of the rays of the caudal fin are tinged with blackish pigment so as to form a narrow darkish posterior border.

This study was based on U.S.N.M. no. 44205 and nos. 44373 to 44375, 6 specimens from Nicaragua; U.S.N.M. no. 123083, 1 specimen from the Atlantic side of Central America; another small specimen, U.S.N.M. no. 83796, from Trinidad; and 1 specimen each for U.S.N.M. nos. 100817, 100847, and 100851, all from Brazil. Also U.S.N.M. no. 83130, without locality, was collected by the Wilkes Exploring Expedition; 8 specimens from Lago Maracaibo, U.S.N.M. nos. 121803 to 121806, collected by me in 1942, and U.S.N.M. no. 123072, 1 specimen from the Gulf of Venezuela.

This Atlantic species ranges from Nicaragua and Lake Yzabal, Guatemala, and Lake Maracaibo, Venezuela, southward to Rio de Janeiro, Brazil.

Oligoplites saurus saurus (Bloch and Schneider)

Scomber saurus Bloch and Schneider, Systema ichthyologiae: 32. 1801 (Jamaica).
? *Centronotus argenteus* Lacepède, Histoire naturelle des poissons **3**: 316. 1802 (Equatorial America).
? *Lichia quiebra* Quoy and Gaimard, *in* Freycinet, Voyage . . . *Uranie* and *Physicienne*, Zool.: 365. 1824 (Equatorial America) (ref. copied).
Chorinemus saltans Cuvier and Valenciennes, Histoire naturelle des poissons **8**: 393. 1831 (Martinique).
Chorinemus quiebra Cuvier and Valenciennes, Histoire naturelle des poissons **8**: 396. 1831 (Brazil; Martinique; Havana).
Chorinemus occidentalis Günther (not of Linnaeus, as *Gasterosteus occidentalis* Linnaeus is not an *Oligoplites*), Catalogue of the fishes in the British Museum **3**: 475. 1860 (Jamaica; San Domingo; Trinidad; Puerto Cabello; Bahía).
Oligoplites occidentalis Goode and Bean, Proc. U. S. Nat. Mus. **5**: 237. 1882 (Gulf of Mexico). —Jordan and Gilbert, Proc. U. S. Nat. Mus. **5**: 270. 1882 (Pensacola, Fla.).
Scombroides occidentalis (in part) Jordan and Gilbert, U. S. Nat. Mus. Bull. 16: 447, 913, 973. 1882 (Central America, West Indies to New York). (On p. 973 the name is corrected to *O. saurus.*)
Oligoplites rathbuni Ribeiro, Arch. Mus. Nac. Rio de Janeiro **17**: (Carang.) 8. 1915 (Bahía).—Fowler, Arq. Zool. Est. São Paulo **3**(6): 152. 1941 (Bahía).
Oligoplites saurus Berg. Ann. Mus. Nac. Buenos Aires **4**: 38, 1895 (Montevideo).—(in part) Jordan and Evermann, U. S. Nat. Mus. Bull. 47: 898, pl. 138, fig. 378, 1896. 1900 (Tropical America; New York to Florida; West Indies). —Evermann and Marsh, Bull. U. S. Fish Comm. **20**, pt. 1: 127, pl. 7. 1902 (Puerto Rico).—(in part) Gilbert and Starks, Mem. California Acad. Sci. **4**: 70. 1904 (Florida; Jamaica).—Fowler, Proc. Acad. Nat. Sci. Philadelphia, 1905: 59 (Fort Macon, N. C.; Key West, Fla.).—Jordan and Thompson, Bull. U. S. Bur. Fish. **24**: 237. 1905 (Garden Key, Fla.).—Smith, The fishes of North Carolina: 200, fig. 81. 1907 (Beaufort, N. C.).—Starks, The fishes of the Stanford Expedition to Brazil: 43. 1913 (Natal).—Ribeiro, Arch. Mus. Nac. Rio de Janeiro **17**: (Carang.) 7. 1915 (Tropical Pacific and Atlantic from New York to Rio de Janeiro; Bahía).—Fowler, Proc. Acad. Nat. Sci. Philadelphia, 1915: 532 (Trinidad); 1919: 147 (Jamaica).—Devincenzi, Ann. Mus. Nac. Montevideo, ser. 2, pt. 5: 217. 1924 (Montevideo).—(in part) Meek and Hildebrand, The marine fishes of Panama, pt. 2: 390, pl. 39, fig. 1. 1925 (Tropical America).—Devincenzi and Barattini, Ann. Mus. Hist. Nat. Montevideo **2**: pl. 24, fig. 1, 1928.—Beebe and TeeVan, Zoologica **10**(1): 112, fig., 1928 (Port-au-Prince Bay). —Hildebrand and Schroeder, Bull. U. S. Bur. Fish. **43**: 219, fig. 128. 1928 (Lynnhaven Roads, Va.)—(in part) Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 277, 1930 (Central America, West Indies to New York).—Nichols, Sci. Surv., Puerto Rico and Virgin Islands, New York Acad. Sci., **10**(2): 232, fig. 86. 1929 (Puerto Rico).—Fowler, Proc. Acad. Nat. Sci. Philadelphia, 1931: 398 (Trinidad).—Hubbs, Carnegie Inst. Washington Publ. 457: 253. 1936 (Champoton, Campeche; mouth Río Champoton).—Fowler, Proc. Acad. Nat. Sci. Philadelphia, 1937: 310 (Haiti).—Carvalho and Ramos, Bol. Ind. Animal Brazil **4**: 24. 1941 (Rio Ribeira de Iguape).—Longley and Hildebrand, Carnegie Inst. Washington Publ.: 535: 83. 1941 (Tortugas).—Carvalho, Bol. Ind. Anim. São Paulo **4** (3, 4): 53. 1941 (Brazil; Uruguay). —Fowler, Arq. Zool. Est. São Paulo **3**(6): 153. 1941 (Bahía).—Röhl, Fauna descriptiva de

Venezuela: 399, fig. 213. 1942 (coast of Venezuela).

My observations and comparisons of specimens from both the Atlantic and Pacific sides of Central America indicate that the two populations are slightly different structurally but perhaps no more so than those populations along the coasts from Massachusetts to Rhode Island as compared with that in the Gulf of Mexico to Venezuela. By reference to Table 1 it may be noted that a decrease in the number of gill rakers appears to occur northward on both coasts. However, the series are so small that these differences may disappear when several hundred more counts are made. The only other difference observed by me was the more fully developed middle row of minute teeth in those specimens from the Pacific waters. Other differences may be observed when an extensive statistical study is made but I am unable to devote that much time to this problem at present. Tentatively, I am recognizing them as subspecifically different, but not on very good and substantial facts.

The following material, all in the U. S. National Museum, has been examined by me: no. 16354, 1 specimen from Woods Hole, Mass.; no. 14015, 1 specimen from Long Island, N. Y.; no. 50952, 1 specimen from New Jersey; nos. 20726, 25566, 38277, and 39651, 4 specimens from Rhode Island; nos. 5962, 12690, 21486, 26576, 26598, 26607, 30695, 30858, 31922, 38728, 39869, 44649, 47345, 57285, 68555, 80013, 80014, 83797, and 125691, consisting of a large series of specimens from Florida; no. 127479, 3 small specimens from Alabama; nos. 710, 46291, 73575, 118601 to 118603, and 120074, a small series from Texas; nos. 80036, 80057, 80061, and 80062, a small series from Panama; nos. 4733, 9784, 12556, 82409 to 82413, and 82414, a small series from Cuba; nos. 63053, 73832, 8 specimens from Puerto Rico; nos. 30039 and 30040, 2 specimens from Jamaica; no. 94762, 2 specimens from Puerto Colombia, Colombia; nos. 123076 to 123078, 5 specimens from the Gulf of Venezuela; no. 83434, a specimen, locality uncertain, but probably from Rio de Janeiro.

This Atlantic subspecies has a known range from Woods Hole, Mass., to Florida, the West Indies, the Gulf of Mexico, and Central America southward to Montevideo, Uruguay.

Oligoplites saurus inornatus Gill

Oligoplites inornatus Gill, Proc. Acad. Nat. Sci. Philadelphia, 1863: 166 (U.S.N.M. no. 30959 from west coast of Panama).—Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 277. 1930 (Panama).

Chorinemus inornatus Günther, Trans. Zool. Soc. London **6**, pt. 7: 433. 1868 (Pacific coast of Central America).

Chorinemus occidentalis Boulenger, Bol. Mus. Zool. Anat. Comp. Univ. Torino **14**(335): 7. 1899 (Bay of Sta. Elena, Ecuador).

Oligoplites saurus Jordan and Gilbert, Proc. U. S. Nat. Mus. **5**: 625. 1883 (Panama).—Jordan, Proc. U. S. Nat. Mus. **8**: 375. 1885 (Mazatlán; Panama).—(in part) Jordan and Evermann, U. S. Nat. Mus. Bull. 47: 898. 1896 (Tropical America to Baja California).—(in part) Gilbert and Starks, Mem. California Acad. Sci. **4**: 70. 1904 (Panama Bay; Mazatlán, Mexico).—Hildebrand, Bull. U. S. Bur. Fish. **41**: 285. 1925 (El Salvador).—(in part) Meek and Hildebrand, The marine fishes of Panama) pt. 2: 390, pl. 39, fig. 1, 1925 (Panama).—(in part) Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 277. 1930 (Central America to Lower California).—Breder, Bull. Bingham Oceanogr. Coll., **1**(3): 17. 1936 (Conception Bay, Baja California).

Oligoplites occidentalis Jordan and Gilbert, Proc. U. S. Nat. Mus. **5**: 374. 1882 (U.S.N.M. no. 30959, type of *O. inornatus*); Bull. U. S. Fish Comm. 1882, **2**: 110. 1882 (Panama).

This species is scarcely distinct from *saurus* of the Western Atlantic, and I separate them subspecifically on the doubtful bases of a little higher average number of gill rakers in the specimens from the Pacific, along with an extra "middle" row of minute villiform teeth on the premaxillary, scarcely developed in *saurus* of the Atlantic.

The following specimens, all in the U. S. National Museum, were examined: no. 131403, off southern California; nos. 41258 and 54571, 9 specimens from Guaymas, Mexico; nos. 28359 and 29208, 4 specimens from Mazatlán, Mexico; no. 87339, 1 specimen from El Salvador; nos. 50450, 79939, 79963, 79966, 80030, 80048, 80056, 80058 to 80060, 81993, and 123082, numerous specimens from Panama.

This Pacific subspecies ranges from southern California southward to Panama and the Bay of Sta. Elena, Ecuador.

Oligoplites altus (Günther)

Chorinemus altus Günther, Trans. Zool. Soc. London **6**: 433, fig. 1868 (west coast of Panama).—

? Boulenger, Bol. Mus. Zool. Anat. Comp. Univ. Torino **14**(335): 7. 1899 (Guayaquil).

Oligoplites altus (in part) Jordan and Evermann, U. S. Nat. Mus. Bull. 47: 899. 1896 (Panama). —Gilbert and Starks, Mem. California Acad. Sci. **4**: 72, pl. 11, fig. 20. 1904 (Panama market).—Meek and Hildebrand, The marine fishes of Panama **2**: 388, pl. 38, fig. 1. 1925 (Panama).—Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 278. 1930 (Panama).

Two specimens from Panama, U.S.N.M. nos. 80063 and 82043, form the basis on which this study was made.

This Pacific species has been reported from Panama and from Guayaquil, Ecuador.

Oligoplites mundus Jordan and Starks

Oligoplites mundus Jordan and Starks, *in* Jordan and Evermann, Rept. U. S. Fish Comm. **21**: 344. 1896 (Mazatlán) (name only); U. S. Nat. Mus. Bull. 47: 2844. 1898 (San Juan and Algodones Lagoons, Mexico).—Gilbert and Starks, Mem. California Acad. Sci. **4**: 72, pl. 12, fig. 21. 1904 (Panama; Algodones Lagoon and Mazatlán, Mexico).—Starks, Proc. U. S. Nat. Mus. **30**: 784. 1906 (Guayaquil).—Meek and Hildebrand, The marine fishes of Panama, pt. 2: pl. 38, fig. 2. 1925 (Gulf of California to Ecuador).—Hildebrand, Bull. U. S. Bur. Fish. **41**: 285. 1925 (El Salvador).—Jordan, Evermann, and Clark, Rept. U. S. Comm. Fish. 1928, pt. 2: 278. 1930 (Mazatlán).—Tortonese, Bol. Mus. Zool. Anat. Comp. Univ. Torino **47**: 162. 1939 (Callao).

Chorinemus saliens ? Boulenger, Bol. Mus. Zool. Anat. Comp. Univ. Torino **14**(335): 7. 1899 (Bay of Sta. Elena).—? Steindachner, Denkschr. Akad. Wiss. Wien **72**: 126. 1902 (Guayaquil).

Oligoplites altus Jordan and Gilbert, Bull. U. S. Fish Comm., 1882, **2**: 106, 110. 1882 (Mazatlán and Panama); Proc. U. S. Nat. Mus. **5**: 374. 1882 (on U.S.N.M. no. 30969 from Panama).—Jordan, Proc. U. S. Nat. Mus. **8**: 375. 1885 (Panama).—Jordan and Evermann, U. S. Nat. Mus. Bull. 47, pt. 1: 899. 1896 (Panama).

The following specimens were studied: U.S.N.M. nos. 28183, 28354, 28274, 29558, 41257, and 46496, a small series from Mazatlán and the west coast of Mexico; U.S.N.M. no. 87338, a specimen from El Salvador; U.S.N.M. nos. 30738, 30969, 76795, 79936, 79938, 79960, 80027, 80028, and 80051 to 80055, a large series of specimens from Panama; U.S.N.M. nos. 53483 and 88698, 5 specimens from Ecuador.

The entire account by Jordan and Evermann on page 899 in U. S. Nat. Mus. Bull. 47 for *O. altus* appears to have been based on specimens of *mundus*.

This Pacific species ranges from the Gulf of California to Callao, Peru.

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BIOLOGY.—*Suggested terms for the interpretation of speciation phenomena.*[1]

S. DILLON RIPLEY, U. S. National Museum. (Communicated by HERBERT FRIEDMANN.)

In the present state of systematic usage, there is a well-established tendency to revise nomenclature in order to fit in with the new concepts emanating from the laboratory and the field. However, the multitude of speciation phenomena emerging from these studies makes a simple trinomial system seem totally inadequate. Huxley's suggestion (1942, p. 410) about subsidiary terminologies which can be introduced to define "the cytogenetic and ecological data of systematics, and the facts concerning actual or potential interfertility," while still not interfering with the taxonomic convenience of the main terminology, seems a very wise one. A brief discussion of some of these terms follows here, with particular reference to current usage in ornithology. I am grateful to Dr. Herbert Friedmann for several valuable suggestions.

GENUS

The genus as a taxonomic term still lacks reality in genetic expression. We accept it as a valid category, however, realizing that it has reality in nature. The genus is being affected at the present time by speciation work on species problems. Wherever possible species are being combined and reduced in number. As a reflection of this, genera tend to follow suit. Generic names are being used nowadays to express degrees of relationship, a reversion to the Linnaean concept, rather than to express degrees of difference. The introduction of subspecies enables the species category to absorb part of the function previously held by the genus. As well as this the better understanding of the genetic basis for morphological differences tends to reduce the degree of importance formerly attached to obvious structural characters. As species become polytypic, so genera become increasingly polytypic in taxonomic usage, in order to maintain proportion. In ornithology the process of "tidying up" the arrangement of the genera of birds is now proceeding apace.

A definition of the genus as presently understood by speciation-minded ornithologists might read somewhat as follows: a natural catch basket which can be determined on morphological criteria but which so far eludes precise genetic analysis. This catch basket includes a group of species occupying different stages of relationship each to the other, but still apparently akin.

SUBGENUS

In the increasing cases where genera contain a large number of species some effort is usually made, by systematists of every hue, to provide subdivisions, higher than the species level, to define groups of species. Many systematists favor the use of a subgenus category. This is an orthodox category and should be adhered to if possible for convenience's sake. But what does it mean? Ridgway (1886) defines a subgenus as "a subdivision of a genus, of indefinite value, and frequently not recognized by name except in the grouping of species." In other words a subgenus can mean pretty much anything at all. If an author then is to use the term he should specifically define his use of it.

Mayr (1942, p. 290) suggests that subgenus if used in combination with genus, species, and subspecies amounts practically to

[1] Received June 5, 1945.

a quadrinomial system as well as burdening the memory with an extra name to be remembered. He adds that the subgenus is used in ornithology either when an author does not quite dare to create a new genus in the face of growing opposition to such a procedure, or when he does not quite dare to sink an old well-established and well-known generic name. Another comment by Dunn (1943) is that since subgeneric names are indistinguishable from generic ones, there is a tendency for later authors to elevate them to generic rank. These remarks are possibly somewhat facetious, but they emphasize one aspect of the problem, that of the difficulty of the personal equation in authors. It is certainly true that the grouping of species into subgenera with their attendant lists of morphologic criteria, often irrelevant in plastic groups, seems a somewhat static way to list cognate species which are undergoing a dynamic process. I would urge then that plain subgenera not be used unless the particular category to which they belong is strictly defined.

OTHER TERMS

Several terms have arisen recently, some as a result of earlier theoretical work, for example, Kleinschmidt's "Formenkreis" carried further by Rensch, others in response to experimental evidence. Most of these terms are concerned with defining a natural monophyletic group lying somewhere between a species and a genus. Starting with that category most closely approaching the genus and listing them in descending order toward a straight species, we have the following:

(1) *Cenospecies.* Clausen, Keck, and Hiesey (1939) have tried hybridizing many plants belonging to the Compositae. They define cenospecies as those groups of species in which there is an absolute genetic barrier, although the ranges are similar or overlapping. This condition has not been well examined in animals except in *Drosophila* and may not be particularly common. Most closely related animal species seem to be able to produce viable and presumably reproducing hybrids, at least under artificial conditions.

(2) *Interspecies.*[2] I propose the use of the term *interspecies* to define a species group or sympatric subgenus, containing *a closely related group of geographically overlapping species which have attained physiological isolation in nature.* Such species may be monotypic or not. It does not affect the definition whether the species overlap only on the margins of their respective ranges, or whether one species is contained wholly within the range of another, i.e., double invasions of islands. This condition has previously been designated informally as a species group (Dice, 1940) for the deer mice, *Peromyscus*, where two species *leucopus* and *gossypinus* live side by side in part of their range without interbreeding although interfertile in the laboratory. Birckhead and myself (1942) used the term to describe the fruit pigeons of the *Ptilinopus purpuratus* assemblage on the Pacific islands. Similarly Mayr and myself (1941) used species group in discussing the Polynesian triller, *Lalage*, wherein two cases occurred of sympatric species obviously most closely related to each other. Diver (1940) discusses several such cases among plants, invertebrates, and insects. In the great majority of cases, it is at present impossible to prove whether two closely related animal species may be cenospecies or interspecies but this in no way invalidates the theory behind the terms. I can not think of two closely related bird species ever having been proved intersterile.

(3) *Superspecies.* Mayr (1931, p. 2) has proposed the term superspecies (instead of Rensch's "Artenkreis") for a systematic unit containing geographically representative species that have developed characters too distinct to permit the birds to be regarded as subspecies. This term symbolizes the next step but one above a simple polytypic species, containing units which have attained a degree of morphological difference implying reproductive isolation. I feel that Huxley (1942, pp. 179, 407) has confused the terminology somewhat by defining "Artenkreis" as equal to a geographical subgenus and restricting the use of superspecies (or supraspecies as it is sometimes mistakenly called) to intermediate situations in which the majority of forms of a

[2] *Inter-species*, species living among each other.

"Kreis" of allopatric groups are clearly subspecies of a polytypic species; "but a few have diverged further until they are probably or certainly regarded as separate monotypic species." This all seems to be an unnecessary complication, the necessity for which is eliminated by Mayr's amplification of his superspecies definition (1942, p. 169), to include both monotypic and polytypic members which are allopatric and are members of a monophyletic group. Thus geographical subgenus, allopatric subgenus, supraspecies, and the two terms of Clausen, Keck, and Hiesey (l.c.) for examples in plants, namely ecospecies and species complex, may be considered as names for a similar phenomenon as that expressed by superspecies. In the case of the last two terms, the difference between them is whether the species concerned show relative or absolute intersterility. As in the case of cenospecies this is a criterion which has not been proved to apply in the majority of closely related animal species.

Possible mechanisms for the successful maintenance of interspecies in contrast to simple geographical isolation in the case of superspecies have been suggested by several authors. Lack (1941) points out that habitat preferences may serve as a barrier once forms have remet after speciation has occurred. Diver (l.c.) concludes that as complete overlap in an ecological sense is presumably hardly ever present, "drift" or random differentiation in small partially isolated populations may be responsible. Actual psychological or physiological mating barriers are discussed by Dice (l.c.) and Diver (l.c., p. 326). Their relative importance in order to produce drift phenomena is probably great. Muller (1940) indicates the importance of isolation, even in partial degree, in producing effects of reduced fertility and viability after crossing.

The development of such a process is suggested by Huxley (l.c., p. 251) to be occurring among the grackles (*Quiscalus*) where a zone of hybridization between two subspecies increases steadily in area from southwest to northeast. This has a parallel in time, for the original hybridization must have occurred in the southwest and has spread to the northeast. Huxley suggests that the restriction of the hybrid zone at the original point of contact indicates a developing stabilization of the condition of selective disadvantage of the hybrid form. This may eventually be carried to the final stage of elimination of interbreeding, leading to the formation of an interspecies.

With the greater degree of speciation study now being applied in systematic groups, it seems likely that there will be an increasing discovery of cases of partially sympatric or even totally sympatric forms which for one reason or another have succeeded in evolving in spite of being most closely related to each other. It is likely also that in the world of the future with the breaking down, principally by the agency of man, of ecological barriers, more and more species will be thrown in direct contact with each other which previously were spatially isolated. An example of this occurs today on the island of Ceylon, where the extensive foresting and the wide spread of tea plantations with the development of new biotic conditions have disrupted the ranges of many species. Two closely related forms of the genera *Dicrurus* and *Gracula*, which Whistler (1944) calls in each case subspecies believing that they occur in separate ecological zones, have been found by me to occur in the same area without evidence of interbreeding. This is apparently a recent development as Whistler was depending on the early literature for his evidence rather than on newly collected material.

As classification and arrangement of forms in check lists, generic revisions, etc., proceed, it seems important to attain some method of indicating relationships. Some recent authors in ornithology (e.g., Mayr, 1941, and Delacour and Mayr, 1945) have introduced the superspecies concept into formal taxonomic lists. I feel that this procedure is welcome, but that in view of the present state of our knowledge it does not go far enough. It is obvious that geographical isolation is the cornerstone of much of the speciation process, but it is also obvious that physiological isolation as postulated by Dobzhansky (1940) is in

many cases a subsequent development which can result in allowing closely related species to live side by side. Thus to list only superspecies is to fail to give the complete picture of relationship. As an example, Mayr (1941, pp. 91–92) lists several species of kingfisher, including *Tanysiptera hydrocharis* and *T. galatea*. *T. galatea* is combined with several other species into a superspecies, but *T. hydrocharis* is left out because its range overlaps with *T. galatea* in southern New Guinea. Actually *T. hydrocharis* is most closely related to the latter species but has succeeded in attaining physiological isolation allowing it to live in the same area without hybridizing. Another example is the group of kingfisher species, *Halcyon chloris, sancta, cinnamomina, saurophaga, veneratus,* etc., figured by Mayr (1942, p. 181). Several examples in Delacour and Mayr's revision of the duck family (l.c., pp. 37–42) are also pertinent. Thus in the large genus *Dendrocygna, javanica, bicolor,* and *arcuata* are all intimately related, but *bicolor* and *arcuata* alone are bracketed as a superspecies. In the genus *Anas, bernieri* and *gibberifrons* are listed as one superspecies, *castanea* and *aucklandica* as another. And yet *castanea* and *gibberifrons* are so closely related from the morphological and distributional evidence available that were it not for an apparent overlap in their ranges they would be included as races of the same species. These two forms hybridize easily in captivity but apparently not in nature. Finally, in the genus *Aythya* the three species *valisneria, ferina,* and *americana* are all obviously of close relationship. However, geographical overlap prevents their being bracketed as a superspecies. In these cases I would include all the species in one interpsecies.

(4) *Emergent interspecies.* By this term I would define a species group containing a closely related group of geographically overlapping species with a marginal fringe of hybridization. Such a species group would normally include forms, one member of which at least tends to break up into geographical subspecies. Examples of this condition in birds are the woodpeckers *Colaptes auratus* and *cafer* (Huxley, l.c., p. 250), the crows *Corvus corone* and *cornix* (Meise, 1928), and the kingfishers *Ceyx erithacus* and *rufidorsus* (Ripley, 1942). Similar phenomena have been indicated among mammals (Banks, 1929, and Dice, l.c.), reptiles (Stull, 1940), fishes (Hubbs *et al.*, 1943), and insects (Carothers, 1941; Sweadner, 1937).

A special group of emergent interspecies are the cases where the terminal links in a chain of species or subspecies meet. A classic case is that of the gulls, *Larus argentatus* and "*fuscus*" figured by Mayr (1942, p. 180). Apparently there is a certain amount of interbreeding between the terminal links (vide Huxley l.c., p. 244). Another variation occurs in the creepers *Certhia familiaris* and *brachydactyla*, which behave like an interspecies except in the Caucasus where hybridization occurs. A further case of this sort occurs in the tits *Parus major* and *minor* as described by Rensch (1933), where hybridization occurs at certain zones of overlap, not at others.

Possibly the term semispecies of Mayr (1940) could be used to characterize cases such as those listed above. However, as defined by Mayr hybridization was not a criterion. Rather he used it to denote forms which "can be deduced to be geographical representatives of some other species, but have during isolation developed morphological differences of the order of magnitude to be seen between undoubted species." I believe that it would have been far more satisfactory to have defined semispecies with regard to the degree of interfertility rather than with regard to morphological difference by degree. Every taxonomist will have his own standard of degrees of morphological difference as between the category species or subspecies. Semispecies has thus been defined on the basis of a sliding scale.

SPECIES AND SUBSPECIES

Below these categories are species and subspecies which have been frequently and well defined in recent times. However, round the margins of species and subspecies hover cases which seem to be *in statu nascendi*. An example of a species in which two waves have met and hybridized so completely in nature that only one species can

be considered is *Pachycephala pectoralis* in the Solomon and Fiji Islands (Mayr, Amer. Mus. Novit. nos. 522, 531. 1932). This species contains two color forms: (a) with yellow underparts and (b) with white throat, which apparently represent two closely related waves of immigrants. If these waves had not been coextensive, but had remained representative, they would have been considered two well-marked species forming a superspecies. If, on the other hand, some of these forms had been discovered on the same islands without (due to the vagaries of field collecting) any evidence of hybridization, then there would have been no recourse but to consider them an interspecies. A small degree of interbreeding on the fringe of their ranges would have indicated a terminal condition serving to define the forms as an emergent interspecies. In this case, however, hybrizidation is too complete. Hybrid populations have been named and the apparent phenotypic differences have been proved to have little if any genotypic parallel. A somewhat similar example is found in the juncos (Miller, 1941).

It is to be hoped that all cases of this sort will in the future be fully discussed by biologists in order to emphasize the importance of studying these phenomena, both by laboratory and field workers. Only in this way will it be possible to define the speciation process.

SUMMARY

A number of terms are discussed by which various types of speciation may be described. It is suggested that these terms be used as an auxiliary to the main nomenclature of genus, species, and subspecies. It is further suggested that all evidence of unusual cases of speciation phenomena be pointed out and described by scientific writers in order to widen and extend the literature, and thus promote further study.

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ETHNOLOGY.—*Notes from Six Nations on the hunting and trapping of wild turkeys and passenger pigeons.*[1] ERNEST S. DODGE, Peabody Museum of Salem. (Communicated by WILLIAM N. FENTON.)

During the course of a field trip to Six Nations Reserve on Grand River, Ontario, in October 1944, most of the time was devoted to ethnozoological inquiries.[2] The following notes collected on the taking of wild turkeys [*Meleagris gallopavo silvestris* Vieillot] and passenger pigeons [*Ectopistes migratorius* (Linnaeus)] may be of some value, as the turkeys have been extirpated from the area for many years, and the pigeons, of course, are extinct. The data on the pigeons also supplement in a small way the recent study by Fenton and Deardorff. There are few persons living on the reserve old enough to remember the turkeys and pigeons. Because of lack of time and opportunity, inquiry could be made only among the Cayuga and the Munsee-Delaware, also residing on the reserve. This, however, resulted in some interesting contrasts between Iroquois and Algonkian hunting and trapping techniques.

Jerry Aaron, whose Cayuga name is *Sadegǫ'hes*, "Tall like the Trees," 78 years old, remembered that wild turkeys were hunted with the bow and arrow. Another Cayuga, Chief Alexander General or *Desga'heh*, "More than Eleven," corroborated this statement and said also that the Cayuga hunted them to the westward of the reserve before his parents' time.

Sadegǫ'hes told us of a hunting medicine used for approaching turkeys and other game. This medicine was made from a root of a plant, about as long as a man's finger, which the Cayuga call *wutunda'si*, but he could not remember the English name. The end of the root was burned and the resulting smut rubbed on the eyebrows, upper lip, inside of mouth, and on the palms of the hands of the hunter. The huntsman, thus equipped, could approach the turkeys closely as the powerful medicine caused them to stand still.

It is significant that neither of the Cayuga informants had ever heard of using any kind of a trap for catching turkeys.

Quite different from the Cayuga hunting was the Delaware trapping method recalled by Old Jessie Moses, about 80 years of age. He related that in the old days turkeys, called *pele'u* in Munsee, were caught in a trap made of poles driven into the ground with other poles fastened across the top and sides. It formed an enclosure or pen about 3 feet high and 6 or more feet square. The top was disguised with a sprinkling of dry leaves. One end had a low opening beneath the poles into which a trench led, excavated for a distance of about a rod, and sloping sufficiently to allow the birds to enter the pen beneath the lowest pole above the opening. The trench was made like a ramp. Leaves were spread bountifully in the runway and inside the pen. A small sprinkling of corn was put out leading from the woods to the ramp into the trap, and plenty of corn was put among the leaves inside the trap. The turkeys would come along feeding with their heads down and feed right into the trap. When they were through eating they would put their heads up and were imprisoned because they did not know enough to put them down again and find their way out at the place where they entered. Inevitably, in scratching for the corn among the leaves inside the pen, a deep litter of leaves would be backed around the palings and walls and cover the entrance.[3]

Young Jessie Moses, nephew of Old Jessie, said they also caught them with a pole at night when they were roosting. As the birds slept on the limb of a tree, the hunter with the end of a pole kept poking their feet. The disturbed birds would eventually step onto the pole and they could then be lowered to the ground and caught. The spurs of the old gobblers, he had heard,

[1] Received May 28, 1945.

[2] I am indebted to the Peabody Museum of Salem for supporting me on this field trip and to Dr. Frank G. Speck, whom I accompanied, and who has aided me in many ways.

[3] Dr. Speck found the knowledge of a similar pen type of trap surviving among the Delawares of Oklahoma, among the Cherokee of North Carolina, and the Powhatan (Rappahannock) bands of Tidewater Virginia.

were used for arrow points by the Delawares.

Additional Algonkian data from a different area were furnished by Chief Abe Spencer, age 81, a Chippewa, residing at the adjacent Missisauga Reserve. Like the Cayuga, he said that turkeys were shot with bows and arrows and later with guns, but he did not remember hearing of pen traps being used.

Few memories of pigeon hunting exist at Six Nations. The name for the bird, however, was readily recalled by the Cayuga as *tcahko'wa*, and by the Mohawk as *ori·'te*. *Desga'heh*[4] had vivid memories of stories heard from his grandmother about Cayuga passenger pigeon hunts. In his grandmother's time there was a district, about 10 miles west of the Reserve in the vicinity of the present Newtown (*Kana'tasę*) (Ca.), where the pigeons nested in great numbers. At that time the district was covered with pines and white cedars, but it has long since been converted to farmland.

According to *Desga'heh* the Cayuga took the pigeons at night by climbing the trees and removing the young from the nests. Adults were never taken and the white man's method of netting was never used.[5]

After each night of hunting the squabs collected were split and hung in the sun to dry. Thus cured, they were taken back to the reserve where they made superior eating, sometimes well into the winter months. These dried birds were always cooked, before being eaten, in one of several different ways—fried, roasted, or made into soup—and were considered excellent.

The Cayuga did not salt birds and pack them in barrels until shown how by the whites, after which time they began to take the adult birds as well as the nestlings, and market them in barrels, but despite these changes the white man's custom of netting was never adopted. It was thought that they were sometimes salted down in elm bark containers for the Indians own use.

The hunts were conducted by large parties and during the evenings there were social times and dances, but *Desga'heh* could not remember any of the details about these; nor could he recall hearing that Pigeon Dance was performed.

Among the Munsee-Delaware there was but little remembrance of the wild pigeon. Old Jessie Moses could give no details of hunting methods but recalled that only the young were taken and remembered catching a wild pigeon once himself at the age of eight.

Chief Abe Spencer, of the Missisauga Reserve, remembered that the Chippewa shot adult wild pigeons with bows and arrows, and also took the young from the nests. He also remembered seeing and hunting pigeons as a boy but could not recall the details.[6]

[4] Mitchell (1935, p. 62) writing on the pigeon in Ontario, gives the Potawatomi, Chippewa, and Cree names for the pigeon but does not refer to the Iroquois names in the Province.

[5] Fenton and Deardorff (1943, p. 290) cite a Cayuga netting device from Grand River recorded by Waugh in 1918, but it was unknown to the informants we questioned.

[6] Mitchell (1935, p. 113) cites a correspondent to *Forest and Stream* who described New York State Indians shooting pigeons with bows and arrows rather than guns in 1823. (This reference reprinted from the original by Fenton and Deardorff. 1943, pp. 293–294.)

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BOTANY.—*Scab of* Cinchona *in South America caused by* Elsinoë.[1] ANNA E. JENKINS, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering.

The U. S. Board of Economic Warfare, later the Foreign Economic Administration, in charge of collecting strategic materials for the war effort, sent a group of botanists to Central and South America to examine existent stands of *Cinchona* and to determine which species would be suitable for harvest. Herbarium specimens were preserved as vouchers for bark samples analyzed and for future botanical work. On a survey in Colombia, obviously diseased fruits of *C. pubescens* Vahl were found on February 11, 1943, at Lavaderos, near San Agustín, Dept. de Huila, by Dr. F. R. Fosberg. The same capsule deformation was again observed in the Department of Nariño in October 1943. On this occasion Fosberg was accompanied by W. C. Davis, plant pathologist, then on an official mission of the Office of Foreign Agricultural Relations to Colombia. Representative specimens from three different trees (*Davis* 28, 29, and 30, corresponding to *Fosberg* 21255, 21283, and 21281), were referred to the writer for examination upon Davis's return to the United States late in 1943. Laboratory study revealed that capsules, leaves, and young stems were abundantly infected by a fungus of the genus *Elsinoë*. Following Fosberg's recent return to the United States and the receipt of his specimens here, he placed his ample gathering from the tree at Lavaderos (*Fosberg* 20065) at the writer's disposal for study and also permitted her to select part of it for mycological herbarium record (*Fosberg* 20065a).

The symptoms of the disease herein described and the diagnosis of the pathogen as a new species of *Elsinoë* are based particularly on the Davis and Fosberg dry herbarium specimens just mentioned.

Based on his observations during botanical surveys for *Cinchona* in Colombia, Ecuador, and Peru, Fosberg has furnished a general statement relative to the range of the scab in this part of South America, as follows:

"The disease is distributed practically throughout the range of *C. pubescens* in Colombia, i.e., throughout the three Cordilleras of the western half of the country; moreover, a collection of *C. pubescens* and one of *C. delessertiana* Standley from Peru show the same symptoms. Although symptoms of the scab have been looked for on *C. officinalis* L., they have been noticed only on trees of this species in the Coromoro area, east of Charalá and near Florian, both in the Department of Santander, Colombia. In the nursery at Popayán, Cauca, situated among trees affected with the disease, seedlings of the succirubra form of *C. pubescens* were unaffected. In Ecuador the disease was not noted on wild plants of this variety, nor on half a million seedlings growing under nursery conditions."

Typical lesions of the disease are present on botanial specimens collected by Pennell and Killip in the Department of Cauca, Colombia, in 1922 (cf. "Specimens examined," p. 350).

The disease under discussion, being hyperplastic in nature, is here termed "scab of *Cinchona*." This is in accordance with the nomenclature suggested elsewhere (12) for diseases of this type caused by *Elsinoë*, or by *Sphaceloma* De Bary (1, 17) in which form genus they are classified when only the conidial stage is known (cf. 16, p. 307, and 17).

It is impossible at this time to make a statement relative to the actual or potential economic importance of scab of *Cinchona*. Since leaves and young stems are affected (Fig. 2), it is possible that the disease might prove destructive if it were present in the nursery under conditions favorable for its development.

Leaf spot.—On leaves the spots are comparatively few to extremely numerous and may be scattered over a greater or less area of the blade or concentrated on or near the veins; occasionally they are aggregated near the leaf margin (Fig. 1, *A;* Fig. 2, *A*, *E*, and *F*). They are often circular to subcircular but may be elliptical to oblong or irregular, particularly when involving the veins (Fig. 2, *B* and *G;* Fig. 3, *D*).

[1] Received August 29, 1945.

Lesions are raised, dome-shaped, or flattened (Fig. 2, *A* and *B*); in some cases the central part of the spot is marked by an apiculus (Fig. 2, *B*, *b*, and *C*). Where spots are closely grouped, a few may coalesce (Fig. 3, *D*). Abundant infection on veins and midrib results in crowded or extensive coalesced lesions along these structures (Fig. 2, *E*, *F*, and *G*). In general the spots are 0.5 to 1.5 mm, rarely 2 mm, in diameter.

Lesions prominent on the upper leaf surface are often "cinnamon-drab."[2] Where mostly covered by fructifications of the fungus as in Fig. 2, *A*, *a*, they are "dark vinaceous-brown." The coloration of the particular lesion shown in Fig. 2, *A*, *b*, enlarged in *B*, *b*, and *C*, is as follows: Light area around the central apiculus "ecru drab," this surrounded by a "blackish brown" zone constituting a palisade of conidiophores of the pathogen (*Elsinoë*), rim of the platformlike spot where not fungus covered "light brownish drab"; finally, narrow discolored zone surrounding the elevation "dark vinaceous-brown." Where lesions are almost too small to be detected without magnification, the dark surrounding zone assists in marking their position (Fig. 1, *A*). Spots originating on the upper leaf surface are apparent on the pubescent lower side of the blade chiefly as faint vinaceous discolorations. Lesions originating below often are "vinaceous to brown." In this case the lesions form short conical to flattened elevations not uncommonly apiculate; on the upper side of the blade they appear merely as pocklike depressions. Occasionally spots fall away leaving the leaf perforated or with only a transparent network of tissue. The pathological histology of the lesion, which is hyperplastic in nature (see Fig. 3, *E*), corresponds closely to that of sour orange scab, caused by *Elsinoë fawcetti* Bitancourt and Jenkins (4) as carefully depicted by Cunningham (9).

Stem cankers.—Cankers on young stems, as well as on rachis and branches of the inflorescence, may be present in greater or less numbers over a given area, being distributed over all or only part of the circumference. On *Davis* 28 stem cankers are mostly elliptical, or irregularly so, reaching 4 by 5 mm in diameter. Those in close proximity may coalesce, although ordinarily the outline of the original lesion may be followed. Cankers are raised, with rounded to flattened surfaces usually accented by a small central apiculus, smooth as though polished. The main surface of the canker may be longitudinally or concentrically roughened; also, there may be fissures, particularly at the upper and lower margins. The cankers just described (Fig. 2, *D*) are "cinnamon-drab" as compared with the "dark vinaceous-brown" of the stem. Scale-like cankers on a rachis of *Fosberg* 20065 (Fig. 3, *A*, *a*, and *B*) are concolorous with the healthy stem.

Capsule lesions.—Practically all the many fruits on a single inflorescence may be affected by the scab as exemplified by the several complete inflorescences of *Fosberg* 20065 (Fig. 1, *A–C*; Fig. 3, *A*) and by the Pennell and Killip botanical specimens already mentioned. As alluded to previously, it was during the gathering of his no. 20065 that Fosberg's attention was attracted to the diseased condition of the capsules. The striking symptom noted in the field was that, instead of being straight or nearly so, capsules were abnormally curved, at times forming a crescent or practically a circle (Fig. 1, *B*, *a*, and *C*, *a;* Fig. 3, *A*, *a* and *b*) or were otherwise bent and distorted. Such severely affected fruit also may be dwarfed as the specimens show. It is probable that young capsules severely attacked fail to develop or soon fall away.

On capsules, lesions are often particularly numerous as well as generally more conspicuous than on leaves and stems. They are circular to elliptical, ranging from 1 mm or less to 3 mm in diameter, or elongate. Because of their large numbers or extensive coalescence they may occupy much of the capsule surface (Fig. 1, *A–C;* Fig. 3, *A*, *a* and *b*). On this substrate the spots are, as usual, raised, short conic or flattened; the apiculation already described in the case of leaf and stem lesions may be present. On the dry capsules of *Fosberg* 20065, spots appear as "wood brown" encrustations contrasting

[2] Names of colors in quotation marks are from "Color Standards and Color Nomenclature," by Robert Ridgway (1912).

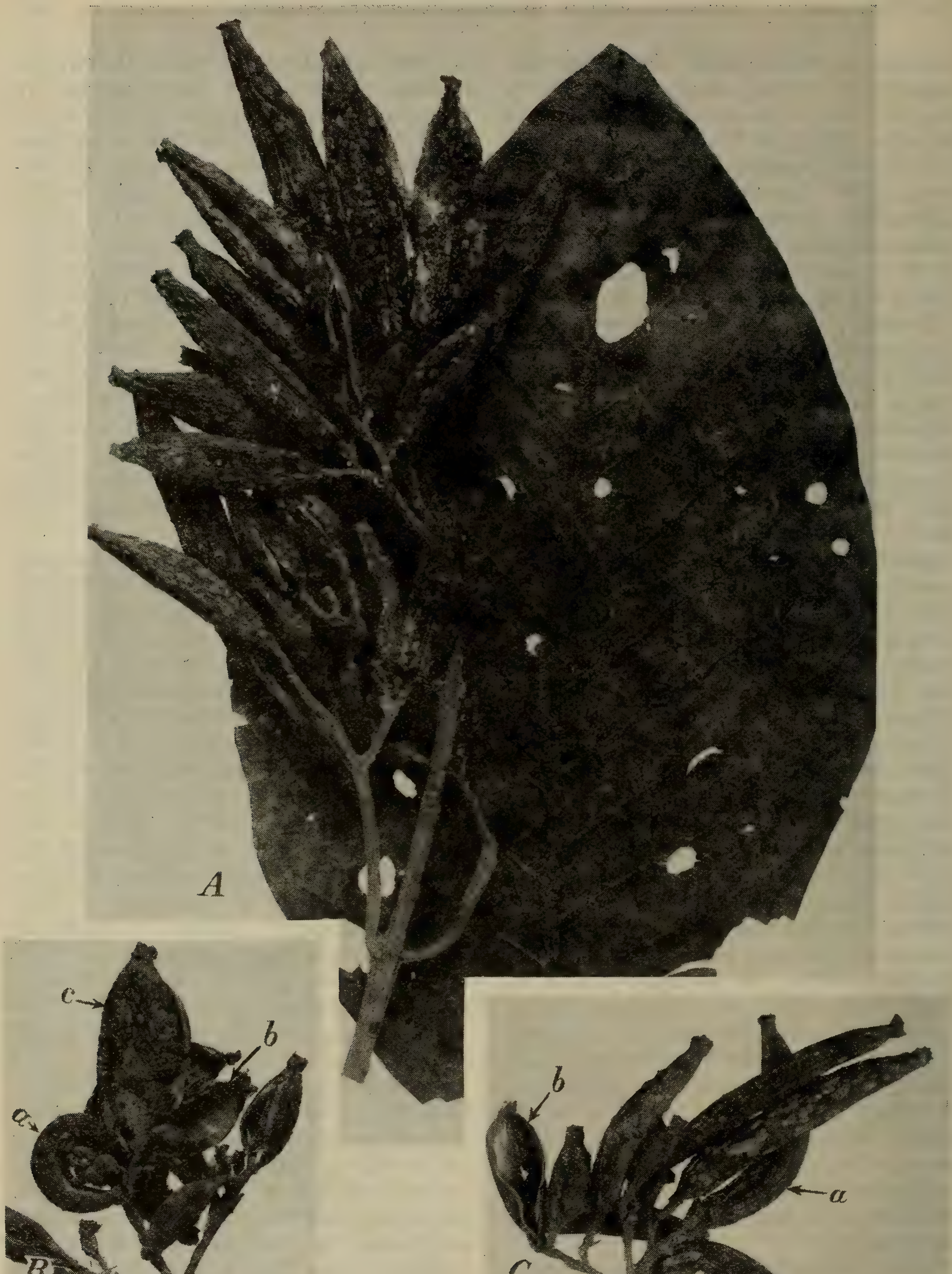

FIG. 1.—Scab on *Cinchona pubescens*, Lavaderos, Colombia, February 11, 1943, *F. R. Fosberg* 20065a: *A*, Part of panicle with numerous cankers on capsules; also leaf with many spots, the greater number clustered on or near midrib and veins and practically all too small to be viewed adequately without magnification, ×1; *B*, *C*, terminal parts of another inflorescence showing abundantly infected fruits; *a*, capsules curved out of normal position; *b*, open capsules showing healthy endocarp; *c*, pericarp of open capsule roughened by the numerous small, in part confluent, lesions covering most of the surface; ×1. Photograph by R. L. Taylor.

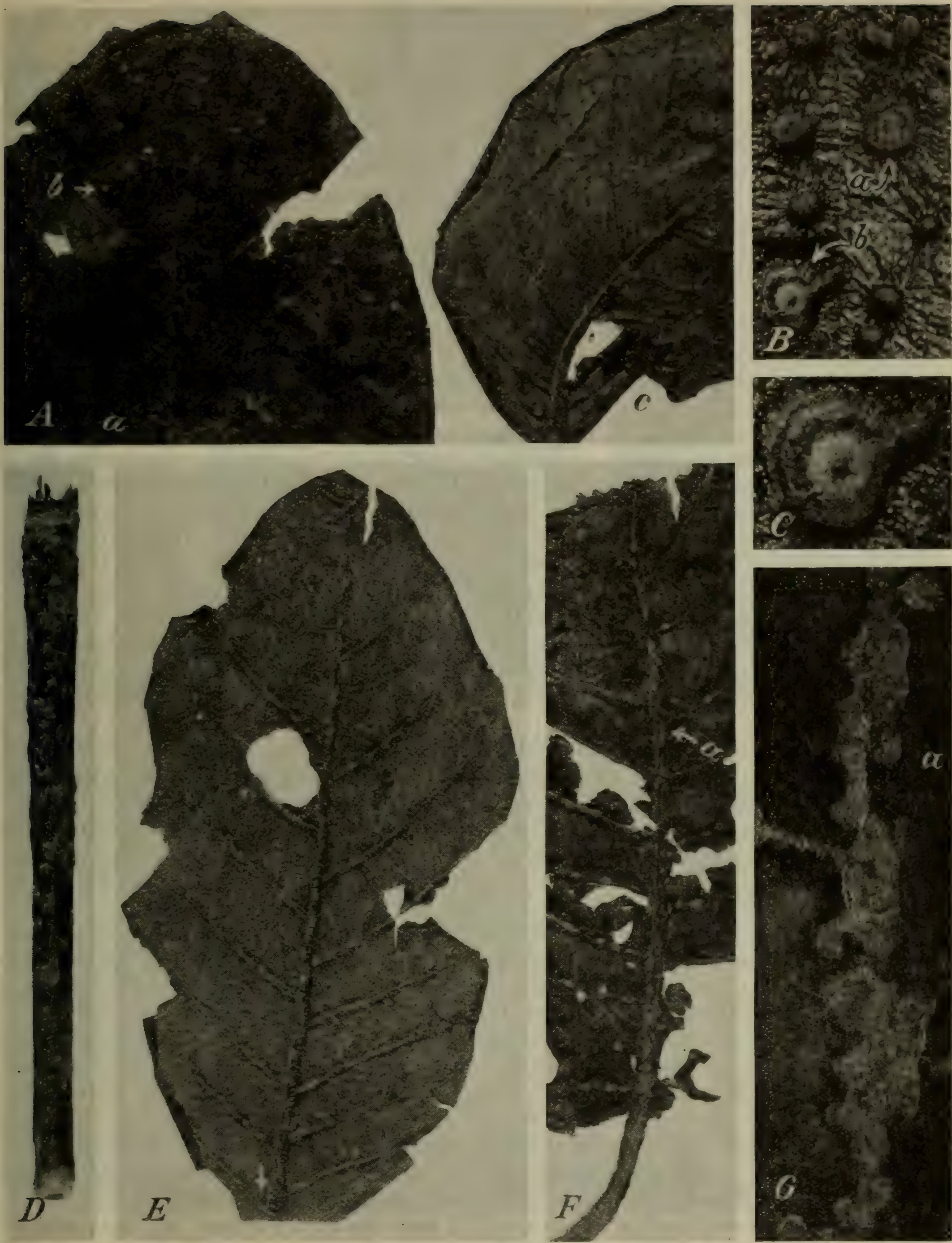

FIG. 2.—Leaf spots and stem cankers of the scab on *Cinchona pubescens*, *A–E*, vic. Chachagui, Colombia, October 16, 1943, *W. C. Davis* 28; *F* and *G*, La Unión, Colombia, October 21, 1943, *W. C. Davis* 29; *A*, *a*, *b*, Spotting prominent on upper side of the leaf; *c*, on lower surface of another blade, ×1; *B*, several raised spots from *A*, *a*, mostly darkened by the palisade of conidiophores of the pathogen (*Elsinoë*) over their surfaces (cf. Fig. 3, *E*), only outer zone covered in *a* and *b*, ×9; *C*, still greater detail of *A*, *b*, ×14; *D*, prominent cankers on young stem, ×1; *E*, *F*, continual vein infection on (*E*) lower surface of a comparatively young leaf, and (*F*) on upper surface of an older leaf, both ×1; *G*, detail of *F*, in the region of *a;* in the original specimen, dark, punctate masses, fructifications of the pathogen, scattered over the surface of the lesion, are best seen in the region of *G*,*a*, ×6. Photographs by M. L. F. Foubert (*A–E*) and by Taylor (*F* and *G*).

sharply with the "sorghum brown" of the smooth unaffected surface. In some cases capsule lesions are not distinguished by their color and, where of small size, would ordinarily be overlooked.

Prominent signs of the scab, visible as seen through a hand lens, are the dark more or less even covering over the entire or outer zone (see Fig. 2, *A* and *B*) of leaf spots, composed of a palisade layer of conidiophores of the pathogen (*Elsinoë*) (Fig. 2, *B* and *C*; Fig. 3, *E* and *F*) and dark pulvinate masses often occupying the central area of the leaf spot, these being ascomata of the pathogen (Fig. 3, *D*, and inset). Less conspicuous signs are smaller dark pulvinate masses, fructifications of the pathogen, on midrib lesions (cf. Fig. 2, *G*, legend for *a*), on stem cankers (Fig. 3, *B*, *a*), and on capsule lesions (Fig. 3, *C*, *a*).

Etiology.—On the basis of its morphology the pathogen of *Cinchona* scab belongs to the genus *Elsinoë* Raciborski (17, 20) of the myriangiaceous family Elsinoaceae. Historical sketches of this genus and family are available elsewhere (for example, cf. 10, pp. 5–8; 16, pp. 306–308). So far as can be determined at present the species on *Cinchona* has not been described hitherto; a diagnosis under a new name is therefore here presented as follows:

Elsinoë cinchonae, n. sp.

Producing few to numerous spots scattered over leaves, stems, and fruit; leaf spots occurring singly or in small groups, sometimes confluent, particularly along veins circular to subcircular, sometimes elliptical to oblong or irregular, raised with rounded or flattened surface, occasionally with a central apiculus, minute to 1.5 mm, rarely 2 mm, in diameter, those originating on the upper leaf surface often "cinnamon-drab" and not uncommonly surrounded by a narrow or comparatively broad "dark vinaceous-brown" zone, those originating on the lower side of the leaf often "vinaceous-brown"; stem cankers mostly elliptical or nearly so, reaching 4 by 5 mm in diameter, sometimes crowded or coalescent, raised with rounded to flattened often roughened surfaces, at times with a central smooth apiculus, occasionally fissured, particularly at upper and lower margins, "cinnamon-drab," or concolorous with the stem; spots on capsules circular to elliptical or elongate, up to 3 mm or so in diameter, or elongate, sometimes confluent over large areas, raised, short conical or flattened, "wood brown" or sometimes concolorous with the healthy capsule surface; entire fruit may be variously deformed, often circular or crescent-shaped; ascomata scattered over the lesions as small raised dark to black punctate areas, most conspicuous as grouped on central area or margin of the leaf spot, round to elliptical, pulvinate, reaching as many as 300μ in diameter by 75μ in thickness, although usually much smaller, erumpent superficial, stroma light colored, dark epithecium, which may become ruptured as the ascoma develops, up to 10μ in thickness, fructification crowded with asci; asci spherical to ellipsoid, 18 to 28μ, with characteristically thickened wall, in upper part reaching 8μ in thickness; ascospores hyaline, 1- to 3-septate, reaching 15 by 15μ; conidial stage (*Sphaceloma*) well developed on leaf spot, there consisting of a more or less continuous layer of dark conidiophores arising from a light-colored stroma covering all or only the bordering zone of the lesion, at the margin raised to form a sporodochium, up to 50μ thick, marginal sporodochium sometimes tilted owing to the development of an ascoma beneath; conidiophores dark, cyclindrical, apex pointed, often 1-septate, 3.5–5 by 8–15μ; the few conidia seen, brown, elliptical or spiculate at one end, 4–5 by 8–10μ.

Maculae plerumque numerosissimae, conspersae, circulares, subcirculares, usque ellipticae, interdum elongatae, elevatae, centro saepe plus minusve apiculiformi, interdum aggregatae vel confluentes, in foliis amphigenae, interdum nervisequentibus, usque 1.5 mm, rare 2 mm, superne conspicuores et saepe cinnamonea-griseae, margine nigro-vinaceo-brunneo circumdatae, inferne vinaceo-brunneae; cancri in caulibus generaliter elliptici, usque 4×5 mm, avellanei, vel discolores, in capsulis usque 3 mm diameter, avellanei vel discolores; ascomata plus minusve numerosa, in maculis foliorum epigena conspicuoria, rotunda usque elliptica, pulvinata, exposita, usque 300μ diameter, 75μ crassa, superficialiter nigro-brunnea; epithecium fuscum, 10μ crassum; asci numerosi, sub-epithecio in regione stromatica hyaline distributi, globosi usque ellipsoidei, apice incrassati, 18–20μ diameter; ascosporae

FIG. 3.—*A–D*, additional illustrations of the scab from *Fosberg* 20065 and 20065a: *A*, *a*, part of an inflorescence, with scalelike cankers on rachis; *b*, capsule abnormally crescent-shape, surface mostly covered with confluent lesions; *c*, leaf spots grouped near midrib, ×1; *B*, rachis cankers from *A*, *a*, fructifications of the *Elsinoë* on them barely visible as minute dark punctate masses (*a*); *C*, *a*, dark fructifications of the pathogen clearly distinguishable on lesions from capsule shown in *A*, *b*; *D* (exclusive of inset), leaf spots from *A*, *c*, with dark ascomata prominent on their surfaces; individual ascomata distinguishable on *a*. *B–D*, ×1; *D* (inset), photomicrograph showing part of an ascoma produced on margin of a lesion from *D*; *b*, epithecium; *c*, two asci with clear, thickened walls, ascospores, dark in photograph, stained red with erythrosin, *d*, epidermis of leaf. *E*, tangential section (unstained) through a leaf spot from Fig. 2, *A*, *a*, showing disorganized hyperplastic tissue of lesion and (*a* to *b*) conidiophore palisade over surface (cf. Fig. 2, *B* and *C*), ×125; *F*, *a*, sporodochium from another section, in comparable position to *E*, *b*, individual conidiophores distinguishable at right, ×225. Photographs by Taylor (*A–D*), Lilian Guernsey (*D*, inset), and by Foubert (*E* and *F*).

immaturae, 1-3-septatae, hyalinae, 15-5μ; status conidiophorus (*Sphaceloma*) in maculis foliorum epigenus prominens; condiophora in palum compactum, expositum superficialiter nigro-brunneum, plus minusve continuum, ex stromate hyaline oriundum, fructificatione tota 30μ crassa, vel marginem maculae versus usque 50μ; conidiophora cylindrica apice acuminato, generaliter continua vel uniseptata, 3.5-5 by 5-15μ; conidia rare visa, brunnea, elliptica, 4-5 by 8-10μ.

Distribution.—Producing the disease "scab of *Cinchona*" on leaves, stems, and fruits of *Cinchona pubescens* Vahl, rarely on *C. officinalis* L., in Colombia, Peru, and possibly Ecuador and on *C. delessertiana* in Peru. *Cinchona* is a genus of the family Rubiaceae.

Specimens examined:[3]

ON CINCHONA PUBESCENS VAHL

Cuatro Esquinas to Río Piendamo, Cauca Valley, Dept. de Cauca, Colombia, from tree in thicket growth ("machimbi"), alt. 1,700-1,900 meters, June 6, 1922, *F. W. Pennell* and *E. P. Killip* 6380 (US). Infection on capsules.

"El Ramal" to Río Sucio, west of Popayán, Dept. de Cauca, Colombia, woodland, alt. 2,000-2,200 meters. July 3, 1922, *F. W. Pennell* and *E. P. Killip* 8088 (US; also in NY). Abundant infection on the many capsules.

Barbosa, 22 km south, on road to Chiquinquira, Dept. de Santander, Colombia, roadside tree 6 meters high, January 4, 1943, *W. C. Steere* 7066 (US). Typical spotting on leaves, inflorescence branches, and on capsules.

Lavaderos, on ridge between Río Naranjo and Río Granadilla, 15 km south of San Agustín, Dept. de Huila, Colombia, in clearing between patches of moist woods, alt. 2,000 meters, February 11, 1943, *F. R. Fosberg* 20065a. Type (USM 90159, IB). This specimen is part of *Fosberg* 20065 (USNA). It was through his observation of the strikingly deformed fruits on this specimen that Fosberg discovered the disease "scab of *Cinchona*" in Colombia.

Vic. Chachagui, 18 km north of Pasto, Dept. de Nariño, Colombia, steep slope, alt. 2,100 meters, October 16, 1943, *W. C. Davis* 28 (USM, IB).

La Unión, about 6 km above, toward Pasto, along road, Dept. de Nariño, Colombia, alt. 2,010 meters, October 21, 1943, *W. C. Davis* 29 (USM).

San Bernardo, on trail to La Cruz, alt. about 2,200 meters, Dept. de Nariño, Colombia, October 21, 1943, *W. C. Davis* 30 (USM).

(The Davis labels indicate that his nos. 28, 29, and 30 were collected in company with Fosberg whose corresponding botanical numbers are 21255, 21283, and 21281 (USNA).

Urubamba River, near the beginning of trail, up to Machu Picchu, Prov. de Quillabamba, Dept. de Cuzco, Peru, June 1943, Hernan Augusto (*Hodge* 6201) (USNA).

ON CINCHONA DELESSERTIANA STANDLEY

Quebrada Pajonal, above Tabaconas, Prov. de Jaen, Dept. de Cajamarca, Peru, November 14, 1943, Earl Rogers s.n. (USNA).

ON CINCHONA OFFICINALIS L.

La Belleza, 10 km north of Florian, Dept. de Santander, Colombia, September 20, 1944, *N. C. Fassett* 25773 (USM). Fassett's regular botanical specimen from the tree bears his number 25772 (USNA).

Discussion.—*Elsinoë* species characteristically infect young growth of their suscepts. From the four species originally described (20), the group has grown, especially in recent years, until it is now admittedly large (cf. 3, pp. 512-513; 8, pp. 150-151; 16, table 1; 18, pp. 165-166), with suscepts ranging from the ferns to the composites. So far as has been determined by inoculation tests, a particular species of *Elsinoë* does not infect unrelated plants (for example, cf. 14); instead, individual species are limited in their pathogenicity to closely related plants or even to a single species in a genus (for example, cf. 13). The example just cited describes inoculation tests on species of different legume genera with a culture of *E. phaseoli* Jenkins (13) from *Phaseolus lunatus* var. *macrocarpus* Benth. Three of the legume genera of the

[3] The herbaria in which are filed the specimens examined during this study are indicated by symbols as follows: IB, Secção de Fitopatologia, Instituto Biologico de São Paulo, Brazil; NY, New York Botanical Garden, Bronx Park, New York, N. Y.; US, United States National Herbarium, Smithsonian Institution, Washington, D. C.; USM, Mycological Collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Plant Industry Station, Beltsville, Md.; USNA, United States National Arboretum, United States Department of Agriculture, Plant Industry Station, Beltsville, Md. The US, NY, and USNA specimens were collected as phanerogamic material and are so deposited.

experiment, other than *Phaseolus*, were known suscepts of other species of *Elsinoë*. In this series of inoculations, which included several commercial varieties of *P. vulgaris* L., only *P. lunatus* var. *macrocarpus* became infected.

Parallel cultural comparisons may serve to demonstrate a close genetic relationship among species of *Elsinoë* from suscept genera within the same family. An example of this is afforded by two species from rosaceous suscepts, i.e., *E. veneta* (Burk.) Jenkins on *Rubus* and *Sphaceloma rosarum* (Pass.). Jenkins on *Rosa*. It is here inferred, of course, that the perfect stage of *S. rosarum*, when and if found, will be referable to *Elsinoë*. As described and illustrated (11, p. 332, pl. 7, *A* and *C*), these two organisms were strikingly similar when cultured under like conditions, although they were also separable. In inoculation experiments on the same set of plants of *Rosa*, *S. rosarum* gave positive results, *E. veneta* negative (11, p. 334).

With such results as these as a background, it would seem that *E. cinchonae* may be limited to genera within the tribe to which *Cinchona* belongs, or even to the genus alone.

Among the Rubiaceae we find *Sphaceloma genipae* Bitancourt (2) described on *Genipa americana* L. and *Elsinoë puertoricensis* Jenkins and Bitancourt (19) on *Randia* spp. including *R. mitis* L. Both *Genipa* and *Randia* belong to another tribe of this family than does *Cinchona*. *E. cinchonae* in its conidial stage is probably to be distinguished morphologically from *S. genipae*. To compare the two critically, however, would require strictly comparable growth of each. For example, small hyaline conidia, such as are described for *S. genipae*, should be compared with similar hyaline conidia of *E. cinchonae;* these latter doubtless exist, although they were not seen during the present study. Conidia from cultures may be required for such a comparison, and after cultures are available still further special culturing (cf. 15, pp. 25–28, figs. 1–9) may be necessary to obtain conidia. It must be borne in mind also that conidia of *Elsinoë* may begin to swell as soon as formed and that this feature presents a real hazard in making species comparisons on the basis of conidial measurements. The diversity of characters in species referable to the form genus *Sphaceloma* has led to difficulties in their taxonomy, as has already been discussed (16, p. 307; 17). The general similarity of growth of these fungi in culture, together with the possibility of separating them by this means, has proved a valuable asset. Colored plates illustrating parallel cultural comparisons of this group are available elsewhere (6, pl. 22; 7, pl. 15; 15, pl. 3); a method of making original isolations by means of microtechnique also has been delineated in another connection (5, p. 134, pl. 18, *H–M*).

Fructifications of the perfect stage of species of *Elsinoë* may be sufficiently distinctive to differentiate them, although care must be exercised in making comparisons. It is not rare, for example, to find only immature ascospores, as in the case of the specimens of *E. cinchonae* examined. Naturally, under all the circumstances, the description of a newly discovered fungus of the genus *Elsinoë* as new, or its identification as a species previously described, may be more or less provisional. In this way it is possible to record taxonomically more of the new suscepts of *Elsinoë* and *Sphaceloma* that are constantly being discovered in various parts of the world than would otherwise be the case. As additional pertinent data are obtained appropriate revisions may be made.

As at present described, *E. cinchonae* and *E. puertoricensis* appear to be distinct species. *E. puertoricensis* has pulvinate as well as applanate ascomata, with an indefinite epithecium. Asci, not particularly crowded in the fertile stroma, are often distributed in one horizontal plane. In *E. cinchonae* only pulvinate or practically hemispherical ascomata have been seen; this more regular form may be accounted for by the better-developed epithecium, which in one instance had ruptured, exposing the underlying hyaline ascigerous stroma. In this species on *Cinchona* the fertile stroma is extremely crowded with asci, which are oriented in different planes.

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BOTANY.—*Accessory vascular bundles in* Murraya koenigii *(Linn.) Spreng. (Rutaceae: Aurantioideae).*[1] Frank D. Venning, University of Miami. (Communicated by Walter T. Swingle.)

From time to time plant anatomists have reported the presence of "accessory," "free" or "unattached" vascular bundles in various floral parts of several plant families. Varying amounts of significance have been given them by investigators. Unattached bundles, which are amphiphloic, or concentric, are described by Arber (*1*) as occurring in the genera *Lunaria, Sisymbrium,* and *Raphanus* and are figured in petals of *Lunaria,* stamens of *Sisymbrium,* and ovule of *Raphanus.* These bundles are described as passing through an amphiphloic stage, finally becoming collateral by the time the petals are free.

[1] Received October 1, 1945. Grateful acknowledgment is made to Dr. Walter T. Swingle for his suggestions in preparing this paper and to the Science Research Council of the University of Miami, Coral Gables, Fla., under whose sponsorship the work was conducted.

Considerable study has been given the various members of the subfamily Aurantioideae in regard to the vascular systems of their flowers. Tillson and Bamford (*2*) studied the floral vascular anatomy of 94 species belonging to 29 genera of the Aurantioideae. They make no mention of accessory bundles in any of the genera or species they studied. Their observations showed that in the genus *Murraya,* including *M. koenigii,* the vascular bundles supplying the various floral parts arose individually from the central cylinder of vascular tissue in the pedicel and that there was no exchange of lateral branch bundles between floral parts.

Accessory bundles were mentioned as occurring in the flowers of the Eureka Lemon, a cultivated variety of *Citrus limon,* by Ford (*3*), and are described as several groups of small vascular traces below the sepals.

"Some of these are not attached below, but others diverge from the vascular cylinder about 3 mm below the bases of the sepals." Ford found that all these bundles extended into the lateral part of the sepals and called them accessory sepal traces. He noted that the provascular elements for these accessory traces are present as early in ontogeny as those of the other bundles of the receptacle and that those attached to the main dorsal sepal traces diverge from them while they are yet a part of the stele.

In connection with an anatomical study of the two commonly cultivated species of *Murraya*, *M. koenigii* and *M. paniculata*, it was found that one of the species, *M. paniculata*, had no accessory bundles, but both loose and attached accessory bundles were found in *M. koenigii*, as shown in this paper.

MATERIALS AND METHODS

The flowers of *M. koenigii* are small and white and are borne in terminal corymbs; sepals free, five in number, about 1 mm long; petals 4–6 mm long, five in number; ten stamens, the alternate ones shorter; the ovary, borne on a short cylindrical disk, is 2- or 3-celled. Flower buds, flowers, and young and mature fruits were collected principally from a large heavily flowering tree growing in Dr. David Fairchild's Kampong in Coconut Grove, Fla. This tree is described and figured by Swingle (*4*). The material was fixed in Formalin-Aceto-Alcohol and imbedded in paraffin. Cross and longitudinal serial sections were cut 10 microns thick and stained with a safranine and fast green staining combination.

OBSERVATIONS

In the pedicel below the base of the sepals, the vascular elements form a continuous cylinder of tissue enclosing the pith. As is the case with many woody stems, the xylem borders the pith on the inside of the stele, and the phloem elements are on the outside; these two tissues are separated by the vascular cambium. On the outside of the phloem a cylinder of elongated parenchyma cells, several cells in thickness, makes up the pericycle. Before and during flowering no lignification of the pericycle occurs, but during the development of the fruit many of these cells become sclerenchymatous fibers.

In the receptacle, bundles of vascular tissue diverge from the stele to supply the various floral parts. The five sepal bundles are the first of such bundles to diverge. These gradually ascend upward and outward away from the stele across the receptacle and then follow a lateral course at the base of the sepals, eventually forming the sepal midribs. As these five relatively large midrib bundles diverge, five bundle trace gaps are apparent in the stele. Just above the point where the sepal midribs begin to separate from the stele, and outside of the pericycle in the cortical parenchyma, the basal limits of loose accessory bundles may appear (Fig. 1), usually as one or two vertical annular vessels in the cortical parenchyma. These vessels are much smaller in diameter than the surrounding cortical parenchyma cells and are spaced approximately halfway between any two diverging sepal midrib bundles. When present their basal ends are always in this relative position in the receptacle.

The course of the unattached bundles is parallel to that of the main sepal bundles across the receptacle, extending upward and gradually outward about halfway across the cortex until on a level with the sepal base. Here they show a lateral course, and extend out into the sepal after branching one or more times. Some branches terminate in the receptacle near the sepal base; others extend to the lower outer edge of the sepal, these usually terminate near an oil gland (Fig. 2).

In mature flowers the largest number of xylem elements occurs in the bundles just as they begin to extend laterally from near the center of the cortex to the sepals. The elements at this point consist of two to four annular vessels and eight to ten spiral vessels, which are identical in appearance with the annular and spiral vessels of the primary xylem in the stele. From here downward the number diminishes rather rapidly, until at the lower end only one or two vessels can be observed; these are always annular in nature, spiral vessels appear higher up in the bundle. Directly below the lowest xylem a few elongated parenchyma cells are sometimes present; these extend downward directly beneath the last lignified vessel for 10 or 20 microns. Under-

neath these there are no evidences of provascular parenchyma, only the large, isodiametric cortical parenchyma cells.

In the portion of the bundle extending laterally the width in every case gradually diminished as the sepal base was ap-

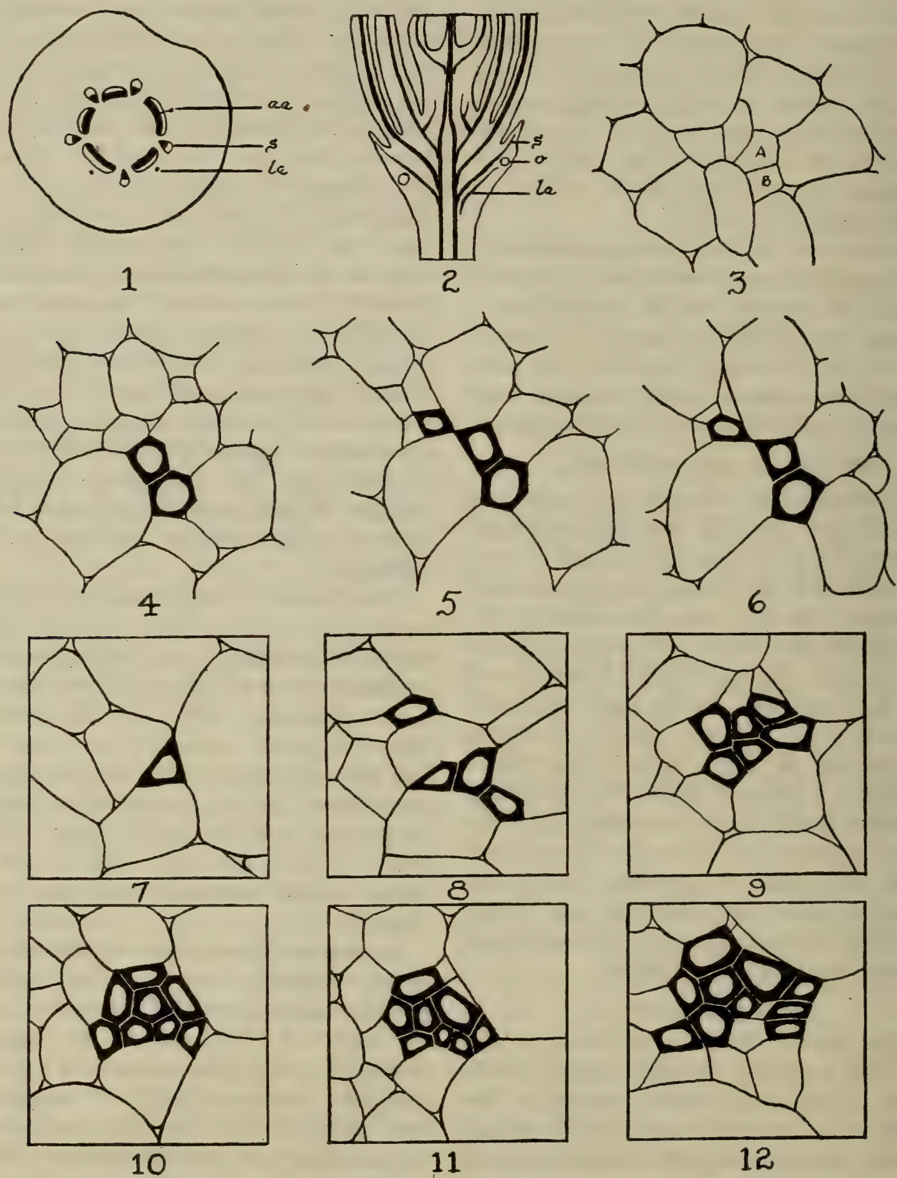

FIG. 1.—Diagram of cross section of the base of a flower at the point of origin of the accessory bundles: *aa*, attached accessory bundle; *s*, sepal midrib bundle; *la*, loose accessory bundle. FIG. 2.—Diagrammatic longitudinal view of base of a flower, showing position of a loose accessory bundle in relation to the main vascular system and floral parts: *s*, sepal midrib bundle; *o*, oil gland; *la*, loose accessory bundle. FIG. 3.—Arrangement of parenchyma cells 10μ beneath the lower limit of the loose accessory bundle shown in Fig. 4; cells A and B are elongated parenchyma cells beneath the two xylem elements shown in Fig. 4. FIGS. 4–6.—Three successive sections 10μ apart of the basal portion of a loose accessory bundle. FIGS. 7–12.—Six successive sections 10μ apart of the basal portion of a loose accessory bundle, showing the progressive increase in the number of xylem elements as the bundle ascends. (Fig. 1, $\times$30; Fig. 2, $\times$12; Figs. 3–12, $\times$550. FIGS. 4–6 are from slides S. & V. 57 B, Figs. 7–12 from slides S. & V. 57 I, in Univ. Miami Tropical Botany Histological Research Collection.)

proached. At this extremity not all the cells composing the bundles had become lignified, but these proxylem cells were easily distinguished from those of the cortical parenchyma, as they had very small diameters, dense cytoplasm, and were more elongate. The average length of 23 such bundles from their first appearance in the cortex to their ultimate termination was 0.475 mm.

Although xylem was well differentiated in the loose accessory bundles, no phloem or phloem parenchyma was observed in connection with them in *Murraya koenigii*. It is true that a few small parenchyma cells often exist in conjunction with the xylem in the large portion of the loose bundles, but near the basal portion of the bundles these cells were often lacking, and they were never numerous. Although smaller than most cells of the cortical parenchyma, they do not show the cell shape or elongation of the protophloem and metaphloem parenchyma of the stele, and of course they have no sieve plates. Rather, they seem to be small, irregularly isodiametric cortical parenchyma cells.

In addition to the loose accessory bundles some flowers have accessory bundles attached to the main vascular system. These appear in the receptacle at the same level as the lower limits of the loose bundles, but are connected with the vascular elements of the stele which form the petal midribs higher up in the receptacle. These attached bundles extend laterally across the cortex to the sepal bases, but describe a much shorter, flatter arc than the loose bundles, their average length being only 0.220 mm, or about half that of the loose bundles. Structurally they are similar to the loose accessory bundles, being composed of annular and spiral vessels, and apparently also lack phloem. The greatest number of elements in any one bundle occurs at a point about equidistant from the ends, and diminishes to only a few xylem elements at each end. At the base only three or four xylem elements are attached to the petal midrib.

Attached accessory bundles are not always present in any given flower, and no more than two attached accessory bundles were observed in any one of 22 flowers studied. Data concerning these flowers are listed in Table 1. It has not been determined whether the attached accessory bundles are branches of the petal midrib or bundles that arise independently and later continue to differentiate downward, ultimately connecting with the xylem of the stele. Studies of these bundles in young flower buds suggest this latter concept.

Table 1.—Occurrence of Accessory Bundles in 22 Flowers of Murraya koenigii

Total accessory bundles per flower	Number of loose accessory bundles	Number of attached accessory bundles
0	—	—
0	—	—
1	1	—
1	1	—
1	1	—
2	—	2
2	1	1
2	1	1
2	1	1
2	2	—
2	2	—
2	2	—
2	2	—
2	2	—
2	2	—
2	2	—
3	2	1
3	3	—
3	3	—
4	3	1
4	4	—
5	5	—

The calyx is persistent after abscission of the petals and stamens and remains fresh and green during the development of the fruit. The calyx has reached its maturity when the petals and stamens are abscissed from the flower, as sections of the basal portions of mature fruits show its dimensions are no larger than they were in mature flowers. The loose and attached accessory bundles were no larger in these sections than in those of mature flowers; evidently they reach their maximum growth at the same time as the calyx.

The irregular occurrence of both the loose and attached accessory bundles in any given flower can not as yet be explained. It seems to have no relation to the position of the flower on the large much-branched terminal corymb, and no other features of the floral anatomy seem to be correlated with their occurrence or nonoccurrence.

Preliminary studies of serial microtome sections of flowers of other species of the Aurantioideae have shown that loose or attached accessory bundles or both occur in 16 species in both of the tribes 4 of the 6 subtribes, and 8 genera. These bundles show great diversity in structure, course, and branching from those described for *M. koenigii*. On the other hand, a very thorough study of several other species of the Aurantioideae has not disclosed a single accessory bundle.

SUMMARY

Although the vascular anatomy of the orange subfamily has been under study for over three-quarters of a century, Ford (*3*) was the first person to mention the presence of accessory bundles, which he described in the lemon. The present paper describes loose and attached accessory bundles which occur in the receptacle and calyx of *Murraya koenigii* and discusses their histology and relation to the main vascular system. It is pointed out that accessory vascular bundles are of widespread occurrence in the flowers of many other members of the subfamily Aurantioideae.

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ENTOMOLOGY.—*Concerning Neotropical Tingitidae (Hemiptera).*[1] C. J. Drake and E. J. Hambleton.

The present paper contains notes on 57 species of Neotropical Tingitidae, including the descriptions of two new genera and 22 new species. The types are in the Drake collection. The collections were made by E. J. Hambleton.

Family PIESMIDAE

Piesma cinerea (Say)

Los Cerritos, Guatemala, 18 specimens, taken on *Amaranthus*, July 5, 1944. This species is widely distributed, ranging from Canada south into Argentina.

Family TINGITIDAE

Subfamily Cantacaderinae

Phatnoma annulipes Champion

Turrialba, Costa Rica, 2 specimens, on *Vernonia* sp., August 13, 1944.

Subfamily Tingitinae

Monanthia c-nigrum Champion

El Porvenir, Guatemala, 7 specimens, July 9, 1944.

Monanthia loricata Distant

Villavicencio, Colombia, 50 specimens, November 3, 1944.

Monanthia berryi Drake

Machala, Ecuador, 14 specimens, Sept. 27, 1944. Recorded in the literature from Peru.

Monanthia monotropidia Stål

Tingo María, Peru, 3 specimens, September 14, 1944. Villavicencio, Colombia, 5 specimens, November 3, 1944, and San Andrés, El Salvador, 1 specimen, July 21, 1944.

Monanthia senta Drake and Hambleton

Salinas, Ecuador, 12 specimens, October 14, 1944; Machala, Ecuador, 6 specimens, September 27, 1944.

Monanthia pucallpana, n. sp.

Head black, shining, with five rather short, forward-directed, testaceous spines; eyes black. Antennae moderately long, indistinctly pilose; segment I short, slightly thickened, reddish brown; II slightly slenderer, reddish; III very slender, testaceous, about two and one-half times as long as IV; IV clavate, hairy. Bucculae broad, reticulated, closed in front. Rostrum moderately long, yellowish brown, extending to middle coxae. Legs moderately long, ferrugineous, the tibiae testaceous, the tarsi dark. Body beneath black.

[1] Received May 15, 1945.

Pronotum dark ferrugineous, moderately convex, coarsely pitted, tricarinate, lateral carinae short, present only on triangular process, slightly divaricating posteriorly; median carina more elevated, uniseriate, except posteriorly on triangular process; paranota moderately broad, completely reflexed, testaceous, not touching median carina, with three raised nervures; collar raised, reticulated, testaceous. Elytra ferrugineous, costal area mostly uniseriate, biseriate in widest part, testaceous, with some of the nervures infuscate, the areolae large and hyaline; discoidal area moderately large, with the posterior part of nervure separating it from subcostal strongly curved so as to form a C-shaped expansion in subcostal area, there with an oblique, raised line closing opening.

Length, 3.85 mm; width, 1.25 mm.

Type (male), allotype (female), and 14 paratypes, Pucallpa, Peru, September 5, 1944. This species is most closely related to *M. c-nigrum* Champion and *M. loricata* Distant but is easily separated from them by the wider paranota (roughened with raised, longitudinal lines) and the much wider costal area (biseriate in widest part).

Teleonemia quechua Monte

Aguaytia, Peru, September 10, 1944, 10 examples. Numerous other specimens are also at hand from Satipo, Cañete, Tingo María, Callauga, and Vilcanota, Peru. The many specimens exhibit some variation in size and color, and the male tends to be a little smaller than the female.

Teleonemia lanceolata (Walker)

Tingo María, Peru, 1 male, September 10, 1944. *T. albomarginata* Champion is a synonym of this species. It is widely distributed in Central and South America.

Teleonemia scrupulosa Stål

Villavicencio, Colombia, 1 male, November 3, 1944. The lantana lace bug is common in tropical America.

Teleonemia prolixa Stål

Pichilingue, Ecuador, 1 example, October 1–2, 1944.

Nyctotingis osborni Drake

Tingo María, Peru, 2 examples, from bamboo, September 10, 1944. These specimens are larger than the type and other specimens from Brazil, but there seems to be no structural differences.

Tingis abundans, n. sp.

Head brown, convex, with five testaceous spines; median spine moderately long, porrect; hind pair adpressed, long, the tips extending nearly to the base of antennae; front pair moderately long, directed forward; eyes large, black. Antennae very long, moderately slender, indistinctly pilose, testaceous, the terminal segment mostly black; segment I rather stout, moderately long, about three times as long as II; II slenderer, short; III very long, slender, straight, nearly three times as long as IV; IV moderately long, slightly thickened. Rostrum extending to intermediate coxae, the laminae more widely separated and convex within on metasternum. Body beneath brown. Legs moderately slender, testaceous. Bucculae broad, closed in front. Orifice present.

Pronotum moderately convex, pitted, yellowish brown, tricarinate, each carina composed of one row of tiny areolae; median carina more elevated on collar; lateral carinae almost parallel; paranota narrow, uniseriate, the margin finely serrate, calli distinct, brown. Elytra yellowish brown, a transverse band in front of middle fuscous, the nervures of sutural area more or less infuscate; costal area moderately broad, mostly uniseriate, in the widest part irregularly biseriate; subcostal area finely reticulated, mostly triseriate, quadriseriate in widest part; discoidal area narrow, extending to middle of elytra, widest behind middle, there four areolae deep. Wings longer than abdomen.

Length, 2.90 mm; width, 1.00 mm.

Type (male), allotype (female), and 11 paratypes, Pucallpa, Peru, September 5, 1944. Similar to *T. oliveirai* Drake and Hambleton and *T. saueri* Drake and Hambleton and separated from them by the higher carinae, longer cephalic spines, and more distinctly serrate margins of elytra.

Tingis gamboana, n. sp.

Differs from *T. abundans,* n. sp., by the biseriate costal area and narrower paranota. Pronotum brownish, becoming lighter posteriorly, finely pitted, tricarinate, moderately, transversely convex; lateral carinae low, dis-

tinct, nonareolated, median carina more raised, indistinctly reticulated; collar distinct, areolated; paranota very narrow, slightly wider in front. Head reddish fuscous, with five testaceous spines; median spine very short; front pair longer, directed forward, their tips touching; hind pair much longer, adpressed, extending a little beyond anterior margins of eyes. Antennae testaceous, indistinctly pilose, moderately long; segment I moderately thick, short, about twice as long as II; II slenderer, very short; III straight, about two and one-half times as long as IV; IV moderately long, mostly black.

Elytra testaceous, with a moderately broad, transverse, fuscous band near base; costal area rather broad, regularly biseriate; subcostal area wide, mostly quadriseriate; discoidal area reaching middle of elytra, widest a little before apex, there four areolae deep; sutural area with a spot (veinlet) near base and another before apex fuscous. Legs testaceous, the tips of tarsi dark. Rostrum extending a little beyond mesosternum. Wings almost as long as elytra. Body beneath black, shiny.

Length, 2.90 mm; width, 1.10 mm.

Type (female) and allotype (male), Gamboa, Canal Zone, Panama, on elm, November 16, 1944. The more strongly convex pronotum, much narrower paranota, and the distinct, transverse band of elytra separate this species from *T. saueri* Drake and Hambleton and *T. oliveirai* Drake and Hambleton. The lateral carinae are also lower and the margins of elytra and paranota indistinctly serrate.

Amblystira fuscitarsis Champion

Guatemala City, Guatemala, November 23, 1944, 85 specimens, from *Derris elliptica*. Known also from Panama, Colombia, Cuba, Haiti, and Brazil.

Amblystira pallipes Stål

Tingo María, Peru, September 7, 1944, 1 specimen, taken sweeping vegetation. Specimens are also at hand from Brazil, Colombia, and Venezuela.

Sphaerocysta nosella, n. sp.

Small, testaceous, the cysts dark fuscous, the pronotum dark ferrugineous. Pronotum moderately convex, finely pitted, tricarinate; carinae distinct, low, the lateral pair parallel, the median terminating behind in a small subconal cyst. Hood moderately large, narrowed anteriorly, wider than high, its greatest width and length about equal, some of the areolae subhyaline, paranota moderately wide, uniseriate, the areolae hyaline.

Elytra widest at base, thence moderately narrowed posteriorly. The outer margin broadly rounded; costal area wide, biseriate, the areolae clear, large, not arranged in very regular rows; sutural area with moderately large, clear areolae; cyst moderately large, inflated, very dark. Body beneath brown. Legs testaceous, rather slender, the tarsi dark. Rostrum extending on metasternum. Antennae testaceous, the terminal segment mostly brownish black; segment I moderately swollen, nearly twice as long as II, the latter short; III long. slender, indistinctly pilose, three times as long as IV, the latter thickened apically.

Length, 2.10 mm; width, 1.00 mm.

Type (male), allotype (female), and 9 paratypes, Vinces, Ecuador, October 14, 1944. It resembles *S. inflata* Drake but is much smaller with narrower and uniseriate paranota, blackish cysts, and slenderer legs and antennae. This is the smallest member of the genus, and the nervures are much more delicate.

Phaeochila, n. gen.

Pronotum moderately convex, narrowed anteriorly, clothed with fine, long hairs, pitted, tricarinate; collar distinct, raised at middle so as to form a small hood, there slightly projecting in front; paranota narrow, uniseriate; head smooth, with spines absent or greatly atrophied. Bucculae short, reticulated, contiguous in front. Rostral channel wide; rostrum moderately long. Orifice present. Hypocostal ridge uniseriate. Antennae rather long, moderately stout, pilose; segment I rather short, stouter and longer than II; III longest; IV slightly thicker than III, moderately long. Legs moderately long. Elytra divided in the usual divisions, with a distinct, inflated area a little behind middle of nervure separating discoidal and subcostal areas, indistinctly clothed with fine, very short hairs; discoidal area not reaching middle of elytra.

Type of genus, *Phaeochila hirta* (Monte) =*Amblystira hirta* Monte.

This genus is allied to the genus *Acanthocheila* Stål and may be separated from it by the tricarinate pronotum, absence of spines on

the margins of paranota and elytra. Separated from *Amblystira* Stål by the hood and tumid elevation of elytra; from *Sphaerocysta* Stål by the lack of pronotal cysts and shorter lateral carinae.

Phaeochila hirta (Monte)

Amblystira hirta Monte, Arq. Inst. Biol. **2**: 284, fig. 5. 1940.

Pucallpa, Peru, 7 specimens, September 5, 1944. This is the first record of this interesting species in Peru.

Leptocysta sexnebulosa Stål

Villavicencio, Colombia, 1 female, November 3, 1944.

Acanthocheila dira, n. sp.

Similar to *A. armigera* Stål in size and general appearance. Head black, with a long, median, erect, testaceous spine; hind pair of spines long, testaceous, adpressed; extending beyond eyes; segment I brown, thick, narrowed at base, three times as long as II, II short, brownish, slender; III long, testaceous, slightly bent, three times as long as IV; IV moderately thickened, blackish, testaceous at base. Legs rather slender, pale stramineous, moderately hairy, the tips of tarsi dark. Rostrum brownish, dark at tip, reaching hind margin of mesosternum.

Body beneath black, shiny; abdomen in female wide, broadly expanded, wings a little longer than abdomen. Hemelytra much more sharply expanded near base than in *A. armigera,* testaceous, considerably embrowned at base; costal area mostly biseriate, with brownish band near base; discoidal area short, mostly four areolae deep; subcostal area broad, closely reticulated within opposite discoidal area. Pronotum unicarinate, transversely convex, pitted, brown; paranota very narrow, uniseriate, the outer margin armed with much longer spines than in *A. armigera,* the second, third and fourth spines sharply reflexed. Apex of hind triangular projection truncate.

Length, 3.25 mm; width, 1.75 mm.

Type (female), El Porvenir, Guatemala, July 9, 1944. Separated from *A. armigera* Stål by the very long, erect, median spine of head, very long marginal spines of paranota and the more sharply widened basal portion of elytra.

Acanthocheila armigera Stål

Many specimens, the commonest member of the genus; Tingo María, Peru, September 14, 1944, and Machala, Ecuador, September 27, 1944; Villavicencio, Colombia, November 3, 1944; El Porvenir, Guatemala, July 9, 1944.

Leptopharsa dapsilis, n. sp.

Elongate, rather broad, testaceous, the head and pronotum (except hind process) black. Head short, the spines greatly reduced; median and anterior pair represented by small tubercules; hind pair very slender, adpressed, testaceous. Antennae long, brown-fuscous, distinctly hairy; segment I moderately long, moderately thick, not quite three times as long as II; II short, slenderer; III straight, very slender, clothed with moderately long hairs, slightly more than three times as long as IV; IV moderately long, clothed with longer hairs, slightly thickened, black. Legs long, slender, dark brown; rostrum yellowish brown, dark at apex, extending a little beyond end of sulcus; rostral channel very wide, the laminae low. Bucculae testaceous, closed in front.

Pronotum moderately convex, pitted, tricarinate; median carina testaceous foliaceous, uniseriate, distinctly higher than lateral, the areolae moderately large; lateral carinae testaceous, rather short, terminating anteriorly at middle of disc, subparallel, uniseriate, the aerolae small. Hood subglobose, moderately large, testaceous, slightly projecting in front. Paranota testaceous, moderately large, moderately reflexed, the outer margin rounded, mostly biseriate, the areolae moderately large. Elytra moderately broad, testaceous; costal area broad, biseriate along basal portion, triseriate in widest part, the areolae large and hyaline; subcostal area narrow, mostly triseriate, the areolae small; discoidal area small, not reaching middle of elytra, considerably embrowned, narrowed at base and apex, widest behind middle, there four areolae deep; sutural area closely reticulated at base, there considerably embrowned. Wings extending a little beyond apex of abdomen.

Length, 3.95 mm; width, 1.55 mm.

Type (male), allotype (female), and 86 paratypes, from *Olmediella betschleriana* (Goepp.), Guatemala City, Guatemala, July 9, 1944. The shorter lateral carinae separate this species from all other members of the genus.

Leptopharsa deca, n. sp.

Differs from *L. usingeri* Drake in the biseri-

ate paranota, low carinae, differently formed hood, and fuscous apical portion of elytra. Antennae moderately long, slender, testaceous; segment I strongly incrassate, brownish, short, twice as long as II; II slender, slightly thicker than III, testaceous; III slenderest, about three times as long as IV; IV mostly brownish black, slightly thickened. Bucculae broad, meeting in front, testaceous, becoming brownish above. Rostrum extending beyond middle of mesosternum. Rostral laminae strongly foliaceous on mesosternum, narrowed posteriorly, the ends meeting behind; laminae lower on metasternum, cordate. Legs slender, testaceous, the tarsi darker. Head with moderately long, testaceous spines.

Hood rather large, a little longer in female than male, covering most of head, inflated, highest (crest) in front of center, slightly longer than high, higher than broad, the nervures embrowned. Paranota testaceous, biseriate, the areolae rather large, hyaline. Pronotum moderately convex, brown; carinae distinct, uniseriate, the areolae small, the lateral carinae slightly divaricating anteriorly. Elytra moderately broad, slightly constricted beyond middle, widest before apex, the tips separated in repose; costal area broad, mostly triseriate, quadriseriate in widest part, testaceous, the areolae large, clear; subcostal area finely areolated, brown, five areolae deep; discoidal area brown, not quite reaching middle of elytra; widest beyond middle, there five areolae deep, with a black-fuscous mark near middle of outer boundary; sutural area mostly clouded with fuscous, some of the apical areolae partly hyaline.

Length, 3.10 mm; width, 1.40 mm.

Type (male), allotype (female), and 3 paratypes, Pichilingue, Ecuador, October 1–2, 1944. The hood is much smaller, the first antennal segment much shorter and thicker, and the carinae much lower than in *L. praestantis* Drake. The meeting of the tips of the mesosternal laminae closes the rostral channel, but in a much different way structurally than in the genus *Gargaphia* Stål.

Leptopharsa ovantis, n. sp.

Differs from *L. furculata* (Champion) in having biseriate paranota, black-fuscous first antennal segment and slightly smaller hood. Color marking very similar to *L. furculata*. Antennae rather long, indistinctly pilose; segment I moderately long, moderately incrassate; three times as long as II; II short, slenderer, testaceous; III long, straight, testaceous, slightly more than twice as long as IV; IV rather long, mostly black, beset with long hairs. Legs slender, testaceous, other characters very similar to *L. furculata.*

Length, 3.75 mm; width, 1.75 mm.

Type (male), allotype (female), and 3 paratypes, Tingo María, Peru, September 7, 1944.

Leptopharsa angustata (Champion)

Barcena, Guatemala, many specimens, November 28, 1944.

Leptopharsa tenuis (Champion)

Barcena, Guatemala, many specimens, on *Ichthyomethia grandifolia* (Donn. Smith), November 28, 1944.

Leptopharsa laureata, n. sp.

Small, moderately elongate; body beneath brown to black. Rostrum long, extending to end of sulcus, testaceous, black at tip; rostral laminae testaceous, concave within on metasternum. Antennae rather long, slender, indistinctly pilose; segment I black-fuscous, moderately thick, about three times as long as II; II short, testaceous, slightly enlarged; III long, slender, testaceous, about two and one-half times as long as IV; IV mostly dark fuscous, moderately long. Legs long, slender, testaceous. Eyes black. Head black, with five moderately long spines; hind pair testaceous, adpressed; median spine brownish to black, turned downward.

Pronotum black, moderately, transversely convex, pitted; carinae testaceous, low indistinctly areolate, the lateral carinae slightly concave within on disc; paranota testaceous, biseriate, the outer margin rounded; hood small, inflated, slightly projecting in front. Elytra moderately broad, indistinctly serrate along outer margins; costal area testaceous, moderately wide, mostly biseriate, triseriate in widest part, the areolae clear and moderately large; subcostal area narrow, biseriate, the veins black-fuscous; discoidal area extending to middle of elytra, narrow, narrowed at base and apex, four areolae deep in widest part, the veins fuscous-black; sutural area more widely reticulated; the veins infuscate.

Length, 2.20 mm; width, 1.00 mm.

Type (male), allotype (female) and 11 paratypes, Pucallpa, Peru, September 5, 1944. Allied to *L. bondari* Drake and Poor from Brazil but separated from it by the longer rostrum, triseriate costal area in widest part and lower carinae, especially median. The lateral margins of the elytra also are more rounded.

Leptopharsa jubaris, n. sp.

Small, ovate, testaceous, the pronotum brownish. Head black, with rather short, testaceous spines; hind pair adpressed, the three frontal spines shorter, directed forward, sometimes adpressed. Rostrum brownish, extending to metasternum; metasternal laminae cordate. Orifice distinct. Bucculae infuscate, closed in front. Antennae moderately long, slender, testaceous; segment I short, moderately thick, twice as long as II; III very slender, straight, indistinctly pilose, nearly three times as long as IV; IV brownish, moderately thickened, beset with longer hairs.

Pronotum moderately transversely convex, finely pitted, truncate in front, tricarinate; median carina uniseriate, the areolae tiny; lateral carinae less elevated, subparallel; collar raised, with tiny hood; paranota moderately broad, reflexed, testaceous, biseriate in front, uniseriate behind, the outer margin rounded; triangular process testaceous, reticulated. Elytra with tips only slightly separated in repose; costal area rather broad, testaceous, mostly biseriate, triseriate in widest part, the areolae rather small; subcostal area narrow, brownish, mostly biseriate; discoidal area grayish brown to brown, extending to middle of elytra, widest beyond middle, there five areolae deep; sutural area more widely reticulated, the nervures considerably embrowned; wings fumose, longer than abdomen. Body beneath black.

Length, 2.70 mm; width, 1.00 mm.

Type (male), allotype (female), and 12 paratypes, Pichilingue, Ecuador, October 1–2, 1944; 1 paratype, El Topo, Ecuador, October 5, 1944. Separated from *L. distantis* Drake in having the costal area triseriate in widest part, narrower subcostal area, and discoidal area narrower apically.

Leptopharsa lauta, n. sp.

Small, whitish testaceous, the veins in sutural area considerably embrowned, the areolae hyaline, iridescent. Head black, with five long, slender, testaceous spines. Rostrum brown, black at tip, extending beyond middle of mesosternum; laminae low, whitish, testaceous, uniseriate. Antennae moderately long, slender; indistinctly pilose; segment I brownish black, moderately long, moderately thick, nearly three times as long as II; II slenderer, short, brown; III long, very slender, about three times as long as IV; IV moderately thickened, brown, clothed with pale hairs. Body beneath black. Legs very slender, long, yellowish brown, the tarsi dark.

Pronotum moderately convex, black, finely pitted, tricarinate; median carina foliaceous, distinctly more elevated than lateral, composed of one row of high, rectangular areolae; lateral carinae low, each composed of one row of elongate areolae. Hood rather small, slightly compressed laterally, subequal in height and length. Paranota moderately broad, distinctly reflexed, biseriate, the areolae moderately large, the outer margin rounded, beset with moderately long, bristly hairs. Triangular process of pronotum reticulated, whitish testaceous. Elytra distinctly constricted slightly beyond middle, the outer margins armed with rather long, very slender spines; costal area wide, biseriate along basal half, triseriate in widest part, the areolae rather large and not arranged in definite rows; subcostal area moderately wide, biseriate; discoidal area rather short, not reaching middle of elytra, the boundary raised, highest a little behind middle.

Length, 2.30 mm; width, 0.90 mm.

Type (male), allotype (female), and 11 paratypes, Vinces, Ecuador, October 14, 1944. This species may be separated from *L. setigera* (Champion) by its smaller size, narrower paranota and smaller hood. *L. fimbriata* (Champion) is a distinctly larger species.

Leptopharsa luxa, n. sp.

Very small, testaceous, the pronotum, collar, carinae, and discoidal, subcostal, and sutural areas brown; areolae hyaline, the areolae in sutural area infuscate with clear centers. Antennae moderately long, indistinctly pilose, testaceous; segment I brown, short, about twice as long as II; III long, about three times as long as IV; IV mostly black, slightly thickened. Head black; posterior spines testaceous, rather long, adpressed, median spine brown, shorter, directed obliquely upward. Rostrum brownish, black at tip, not quite reaching base of meso-

sternum; laminae widely separated, low, testaceous. Legs slender, testaceous, the tarsi dark. Abdomen beneath black, the sternum brown.

Pronotum moderately convex, finely pitted, tricarinate; carinae sharply raised, uniseriate, the areolae tiny; lateral carinae slightly divaricating anteriorly; collar raised anteriorly, finely areolate; paranota long, narrow, subangularly projecting in front, testaceous, biseriate, the areolae moderately large, hyaline. Elytra widening at base, widest a little beyond base, thence moderately narrowing posteriorly, slightly constricted beyond middle, the apices not overlapping in repose; costal area wide, mostly biseriate, triseriate in widest part, the areolae moderately large; subcostal area narrow, mostly biseriate; discoidal area very narrow, pointed at base and apex, biseriate or triseriate in widest part, not reaching middle of elytra, the areolae small, with whitish opaque centers; areolae of sutural area larger.

Length, 2.00 mm; width, 0.80 mm.

Type (male), allotype (female), and 1 paratype, Vinces, Ecuador, October 14, 1944.

This tiny species is not easily confused with other species of the genus. The size, color pattern of elytra, and rectangular paranota are distinguished characters. In general aspect it resembles somewhat members of the genus *Atheas* Champion.

Leptopharsa divisa (Champion)

Barcena, Guatemala, 1 specimen, November 22, 1944.

Phymacysta tumida (Champion)

Tingo María, Peru, 4 specimens, September 10, 1944; Machala, Ecuador, 2 specimens, September 27, 1944. These specimens tend to be a little larger than most specimens before us from Venezuela, Panama, Trinidad, Haiti, and Brazil. *L. malpighae* Drake from Cuba belongs to the genus *Phymacysta* Monte. *Leptopharsa cubana* Drake is a synonym of *L. malpighae* Drake.

Leptodictya bambusae Drake

Many examples taken on sugarcane, Machala, Ecuador, September 27, 1944; on *Bambusa vulgaris*, San Andrés, El Salvador, July 21, 1944, and El Porvenir, Guatemala, July 9, 1944. This species ranges from Texas to Peru and is recorded from the West Indies. It is also recorded as a pest of maize.

Leptodictya fraterna Monte

San José, Costa Rica, many specimens from bamboo, August 20, 1944. This species is closely related to *L. cretata* Champion from which it differs largely in having the basal antennal segment slightly longer and fuscous-black. The second segment is concolorous with the first.

Leptodictya ecuadoris, n. sp.

Small, black-fuscous, the antennae, paranota and legs testaceous, the pronotum, discoidal and subcostal areas brownish, the areolae of costal area within, the centers of marginal areolae, some of the areolae of subcostal area and paranota hyaline. Head with five, testaceous, very long, slender, porrect spines. The median spine longest. Antennae long, slender, indistinctly pilose; segment I short, a little stouter and about twice as long as II; III slightly more than three times as long as IV; IV slightly thickened, light fuscous, moderately long. Legs long, slender, testaceous. Rostrum extending on metasternum, yellowish brown; laminae testaceous, not widely separated.

Pronotum moderately, transversely convex, distinctly pitted, sharply tricarinate; carinae testaceous, each uniseriate, the lateral carinae parallel; hood sharply raised, highest in front, low behind, compressed laterally; paranota biseriate above (overlapping part). Elytra broad, the tips separated in repose; outer margins broadly rounded, widest before apex; costal area wide, six areolae deep in widest part, the areolae large; subcostal area uniseriate; discoidal area elongate, extending to middle of elytra, narrowed at base and apex, widest near middle, there four areolae deep. Male tending to be a little smaller than female.

Length, 3.00 mm; width, 1.75 mm–1.95 mm.

Type (male), allotype (female), and 35 paratypes, from bamboo, Vinces, Ecuador, October 14, 1944.

Differs from *L. nota* Drake in having elytra much broader at base and of different color pattern. In *L. nota* the elytra are gradually widened posteriorly.

Leptodictya laidis, n. sp.

Head dark reddish brown, convex above, with five long, slender spines; anterior pair shortest, fuscous, not quite reaching apex of first antennal segments; median spine longest, fuscous, pale at base, extending beyond middle of second segment; hind pair long, a little

shorter than median, fuscous, pale at base, directed forward, slightly divaricating anteriorly. Antennae rather long, indistinctly pilose; segment I moderately swollen, dark fuscous, about two and one-half times as long as II; II slightly slenderer, short, dark fuscous; III yellowish brown, long, slightly more than twice as long as IV; IV blackish, long, slightly thickened, slightly bowed. Bucculae wide, blackish; rostral channel deep, rather wide, the laminae brown; rostrum brown, black at tip, reaching middle of mesosternum. Abdomen brown beneath. Legs yellowish brown, the tarsi dark.

Pronotum slightly, transversely convex, coarsely pitted, tricarinate, each carina finely uniseriate, the lateral pair parallel, the median slightly more raised in front. Hood low, slightly produced in front, the areolae small, whitish, the nervelets infuscate. Paranota white-testaceous, uniseriate behind, biseriate in front. Elytra broad, roundly expanded at base, the tips separated; costal area very wide, rather widely reticulated, five or six areolae deep in widest part, the nervures mostly dark fuscous, the areolae at base and a transverse band (three areolae deep) clear, the rest of the areolae largely infuscate; discoidal area elongate, extending beyond middle of elytra, narrowed at base and apex, the areolae clear, the veins dark fuscous; sutural area, widely reticulated, the nervures dark fuscous, some of the areolae clear or not entirely infuscate. Wings smoky, nearly as long as abdomen.

Length, 3.80 mm; width, 2.10 mm–2.25 mm.

Type (male), allotype (female), and 40 paratypes, from bamboo, Villavicencio, Colombia, November 3, 1944. This species is very pretty, and the color of the elytra is difficult to describe because of the variation in fuscous color of areolae.

Leptodictya nigrosis, n. sp.

Broad, closely reticulated, dark fuscous, with a large pale spot in costal area opposite apex of discoidal area, the areolae of paranota clear. Head black, with five rather long, brownish spines. Legs slender, brownish. Rostrum brownish, reaching beyond mesosternum. Antennae moderately long, indistinctly pilose; segment I short, dark fuscous, nearly twice as long as II; II slender, yellowish brown; III long, yellowish brown, three times as long as IV; IV blackish, slightly enlarged, clothed with long hair.

Pronotum moderately, transversely convex, closely pitted; carinae foliaceous, each uniseriate, the areolae small; lateral carinae slightly convex within in front, the median a little more elevated. Hood rather small, scarcely produced in front, tentiform, the areolae whitish opaque. Paranota moderately broad, the reflexed part biseriate. Elytra very broad, rounded at base; costal area very wide, with four or five transverse nervures slightly enlarged, the areolae small, whitish or fuscous opaque; subcostal area narrow, biseriate; discoidal area large, extending beyond middle of elytra, narrowed at base and apex, widest near middle, the areolae confused in arrangement and several deep in widest part; sutural area more widely reticulated, the areolae subopaque. Body beneath blackish.

Length, 4.15 mm; width, 2.10 mm.

Type (male), allotype (female), and 4 paratypes, from bamboo, Tingo María, Peru, September 7, 1944. This species is longer than the other dark-colored members of the genus, and more closely reticulated.

Leptodictya parilis, n. sp.

Moderately large, grayish to dark-fuscous, the areolae hyaline. Head black, with five moderately long, brown spines. The median and front pair erect. Eyes large, dark reddish. Rostrum extending beyond middle of metasternum. Antennae rather long, indistinctly pilose; segment I black-fuscous, moderately long, thicker and three times as long as II; II brown, short; III very long, brown; IV dark.

Pronotum moderately, longly transversely convex, grayish fuscous, tricarinate, the carinae indistinctly areolate, moderately large, inflated, slightly produced in front. Elytra moderately wide, becoming slightly wider posteriorly. The outer margin distinctly, finely serrate; costal area moderately broad, rather closely reticulated, with three, transverse, slightly thickened nervures, the areolae not arranged in definite rows, ranging from five deep at base to seven or eight in widest part; subcostal area narrow, biseriate; discoidal area elongate, narrowed at base and apex, widest near middle, there five areolae deep; sutural area large, becoming more widely reticulated posteriorly. Wings not reaching apex of abdomen, smoky.

Length, 3.40 mm; width, 1.60 mm.

Type (male), from bamboo, San Andrés, El

Salvador, July 21–26, 1944. This species with dark fuscous nervures and clear areolae is probably most closely akin to *L. olyrae* Drake but readily separated by the longer hood, longer first antennal segment, lower carinae, more longly convex pronotum and differently shaped elytra. In addition to other characters, the hyaline areolae separate it from other dark-colored species with more or less clouded areolae.

Leptodictya lucida, n. sp.

Large, stramineous, the paranota pale, the areolae hyaline, iridescent. Head brown, with five long spines; anterior pair shortest, directed forward, extending a little beyond middle of first antennal segments; median spine very long, extending to tip of first antennal segments; hind pair long, divaricating toward tips. Antennae indistinctly pilose, moderately long; segment I moderately long, thick, about two and one-half times as long as II; III long, slender, slightly more than twice as long as IV, the latter dark fuscous. Legs slender, yellowish brown, the tarsi dark. Rostrum reaching a little beyond mesosternum. Body beneath brown.

Pronotum moderately, transversely convex, tricarinate, the carinae indistinctly areolate, the median slightly more elevated in front; lateral carinae slightly divaricating anteriorly; paranota moderately wide, wider in front, mostly biseriate. Elytra very broad, divaricating posteriorly, the tips separated in repose, the outer margin broadly rounded; costal area very wide, with three, transverse, slightly thickened nervures, the areolae not arranged in definite rows, about eight or nine deep in widest part, those within along discoidal area smaller; subcostal area very narrow, uniseriate; discoidal area long, narrow, widest near middle, there five areolae deep.

Length, 3.55 mm; width, 2.20 mm.

Type (male), allotype (female), and 1 paratype; from bamboo, Tingo María, Peru, September 7, 1944. Separated from *L. sodalatis* Drake by the shortly pilose antennae, much narrower paranota, differently shaped elytra with smooth lateral margins.

Leptodictya decoris, n. sp.

Moderately large, broad, rather widely reticulated. Head black, convex above, with five brownish spines; front pair extending a little beyond middle of first antennal segments; median and hind pair extremely long, directed obliquely forward. Antennae testaceous, indistinctly pilose, the last segment dark fuscous; segment I rather short, thicker and about twice as long as IV; IV slightly thickened, long, clothed with longer hairs. Rostrum brownish, dark at tip, extending between intermediate coxae. Legs slender, testaceous, the tarsi dark. Body beneath brown to black. Orifice distinct.

Pronotum moderately, transversely convex, closely pitted, polished, the paranota, carinae, collar and hood whitish, the hind triangular process of pronotum testaceous to whitish; paranota moderately wide, with single row of transverse, rectangular areolae; hood small, narrow, slightly projecting anteriorly; carinae low, indistinctly areolate, the median slightly higher in front; lateral carinae faintly diverging anteriorly. Elytra broad, broadly rounded at base white-testaceous, the outer nervure thickened and infuscate, the areolae clear, the veinlets along the outer margins sometimes partly infuscate; costal area broad, with six to seven irregular rows of areolae in greater part; subcostal area narrow, biseriate; discoidal area elongate, narrowed at base and apex, widest near middle, there four areolae deep; sutural area widely areolated.

Length, 3.85 mm; width, 2.00 mm.

Type (male), allotype (female), and 14 paratypes, from bamboo, Tingo María, Peru, September 7, 1944. This very pretty species may be separated from congeners by color, low carinae and broad elytra. The tips of the elytra are moderately separated in repose, the outer margins finely serrate and the areolae somewhat iridescent.

Ulocysta, n. gen.

Distinctly lacy, the areolae large and hyaline. Hood very large, covering base of head and extending posteriorly so as to conceal most of hind process of pronotum, united beneath on triangular process with median carina; median carina foliaceous, arising behind disc and extending a little beyond hind margin of hood. Lateral carinae absent. Paranota moderately wide, foliaceous, moderately reflexed. Head short, armed with five spines. Antennae long, slender; segment I very long, stoutest; II very short; III longest, slenderest; IV very long, half the length of III, slightly thickened. Buc-

culae rather short, reticulated, closed in front. Rostral channel wide; laminal low; rostrum long. Legs slender, rather long. Orifice atrophied. Elytra long, divaricating posteriorly, apices widely separated in repose; discoidal area short, not extending to apex of abdomen. Marginal nervure of elytra and median longitudinal nervure of hood thickened.

Genotype, *Ulocysta praestabilis*, n. sp.

This genus may be separated from *Ambycysta* Drake and Hurd by the much larger hood, unicarinate pronotum, long first and fourth antennal segments and short discoidal area of elytra; and from *Megalocysta* Champion by the long first and fourth antennal segments, raised posterior portion of hood, slender legs and antennae, thinner nervures of reticulations and short discoidal area. The genus *Alloithucha* Drake has much shorter antennal segments and differently formed hood and triangular process of pronotum.

Ulocysta praestabilis, n. sp.

Moderately large, the areolae hyaline, the elytra strongly divaricating posteriorly, yellowish brown, some of the veins darker, head black, the spines testaceous, the median distinctly longer than others. Rostrum brown, extending beyond middle of mesosternum. Body beneath brown. Legs long, very slender, brownish. Antennae long, very slender; segment I brown, about twice as long as the width of head across eyes; II short, brown, slenderer; III yellowish brown, indistinctly pilose, less than twice the length of IV; IV very long, slightly thicker, clothed with longer hairs, distinctly longer than I, becoming black apically. Hood extremely large, somewhat pyriform, twice as long as high, inflated, widely reticulated, testaceous, the areolae hyaline, the median nervure straight, thick and dark; median carina clouded behind, there two areolae high; two very elongate areolae beneath hood. Paranota biseriate, the areolae moderately large, elytra strongly divaricating posteriorly, with marginal and some of the oblique nervures somewhat darkened, the areolae large and hyaline; discoidal area scarcely extending beyond apex of hind pronotal process, mostly biseriate, widest a little in front of apex; costal area mostly biseriate, triseriate in widest part; subcostal area narrower, mostly biseriate; sutural area widely reticulated.

Length, 3.20 mm; width (behind hood), 1.90 mm.

Type (female) and allotype (male), San José, Colombia, November 11, 1944.

Dicysta hollandi Drake

Pucallpa, Peru, 17 specimens, September 5, 1944.

Dicysta vitrea Champion

Tingo María, Peru, 10 specimens, September 10, 1944.

Gargaphia nigrinervis Stål

Tingo María, Peru, 19 specimens, September 10, 1944; San José, and Villavicencio, Colombia, many specimens, November 1944.

Gargaphia seorsa, n. sp.

Very similar in size, color marking and appearance to *G. serjaniae* Drake and Hambleton and differs in having longer spines on head, the elytra broadly ovate, and the paranota expanded laterally at anterior end, there two or three areolae deep. Rostrum reaching beyond middle of mesosternum. Head with five very long, slender spines, the median spines reaching beyond apex of first antennal segment, the front pair a little shorter, the hind pair very long. Paranota rather broad, mostly triseriate, the outer margin rounded, the front margin obliquely expanded. Hood moderately large, slightly smaller than in *G. serjaniae.* Body beneath brown. Elytra broad, the outer margin broadly rounded, widest in front of middle; costal area broad, mostly triseriate, quadriseriate in widest part. Margins of paranota and elytra finely serrate. Other characters very similar to *G. serjaniae.*

Length, 4.25 mm; width, 1.65 mm.

Type (male), allotype (female) and 18 paratypes, Aguaytia, Peru, Sept. 6, 1944, and 13 paratypes, Pucallpa, Peru, Sept. 6, 1944. The paranota are roundly expanded and without distinct anterior margin; the elytra are widest a little before the apices in repose.

Gargaphia neivai Drake and Poor

Pichilingue, Ecuador, 6 specimens, October 15, 1944. Known heretofore from Paraguay.

Gargaphia opima Drake

Numerous examples, Aguaytia and Tingo María, Peru, taken on *Canavalia ensiformis;* 1

specimen, Villavicencio, Colombia, November 3, 1944. *Gargaphia inca* Monte, Rev. Brazil. Biol. **3** (1): 105, fig. 1, 1943, is suppressed as a synonym of *M. opima.*

Gargaphia paula Drake and Hambleton

Tingo María, Peru, 18 specimens, September 10, 1944. Known heretofore only from the Canal Zone, Panama.

Gargaphia acmonis, n. sp.

Moderately elongate, distinctly widening posteriorly. Head black, with five long, testaceous spines, the anterior pair shortest. Antennae long, indistinctly pilose; segment I moderately long, rather stout, fuscous-black, three times as long as II; II short, testaceous, slenderer; III slender, testaceous, approximately three times as long as IV; IV largely fuscous-black, moderately long, clothed with longer hairs. Rostrum extending to middle of mesosternum. Bucculae closed in front. Orifice prominent. Legs long, slender, testaceous, the tarsi dark.

Elytra gradually widening posteriorly, the tips somewhat separated in repose; costal area moderately wide, gradually widening posteriorly, testaceous, uniseriate along basal half, biseriate in widest part, the areolae clear and moderately large. Other characters of elytra and pronotum very similar to *G. lunulata* (Mayr).

Length, 3.30 mm; width, 1.30 mm.

Type (male), allotype (female), and 10 paratypes, Tingo María, Peru, September 10, 1944; also 5 paratypes, San José, Colombia, November 11, 1944; and 1 paratype, Río Rimac, Peru. The shape of the elytra and uniseriate basal half of costal area separate this species from *G. lunulata* (Mayr), its nearest relative.

Corythaica costata Gibson

Many examples, Salinas and Machala, Ecuador, September and October 1944; several specimens, Villavicencio, Colombia, November 13, 1944.

Corythaica cyanthicollis (Costa)

Tingis cyanthicollis Costa, Ann. Mus. Zool. Nap. 1864 (2): 146, fig. 2.
Leptopharsa passiflorae Berg, Hemip. Arg. Add. Emend. 1884: 102.
Corythaica cyanthicollis Drake and Poor, Inst. Mus. Univ. La Plata **3**: 108. 1938.
Corythaica passifloriae Monte, Papeis Avulsos São Paulo 1942: 110.

San José, Colombia, many specimens, November 11, 1944. This species is one of the commonest and most widely distributed tingitids in Neotropical America and one of the most confused species in the literature. Monte, *loc. cit.*, has greatly added to this confusion, and most of his remarks are inept because he has failed to study carefully Costa's figure of *Tingis cyanthicollis.*

Corythucha gossypii (Fabricius)

Barcena, Guatemala, many examples, November 22, 1944; also many specimens from San Andrés, El Salvador, July 21–26, 1944; Pichilingue, Ecuador, October 1–2, 1944; and Managua, Nicaragua, August 1944. This insect is a pest of the cotton plant, eggplant, and pigeon pea.

Corythucha decens Stål

Los Cerritos, Guatemala, many specimens, July 5, 1944.

Corythucha nocentis Drake and Hambleton

Machala, Ecuador, many specimens, September 27, 1944.

Corythucha deceptiva Drake

Santa María de Jesús, Guatemala, many specimens, November 14, 1944.

Corythucha seguyi Drake

Tingo María, Peru, 5 specimens, September 7, 1944.

Corythucha serta, n. sp.

Moderately large, testaceous, some spots on paranota, hood, tumid elevation of elytra and a transverse band near base of costal area brown to black-fuscous, the areolae hyaline. Hood moderately large, constricted near the middle, narrowed in front, inflated behind, the hind portion about as high as wide. Median carina foliaceous, slightly higher in front, mostly uniseriate; lateral carinae not very high, gradually elevated anteriorly, terminating some distance from hood. Paranota moderately large, the outer margin and some of the veinlets beset with short spines. Elytra slightly constricted beyond middle, with rather large tumid elevation; costal area wide, with three rows of rather large areolae, the areolae in transverse band much smaller (except outer

row) and more numerous. Antennae testaceous, moderately long, beset with very long, stiff hairs, the fourth segment embrowned. Bucculae, rostral laminae and body beneath black. Rostrum brown, extending to middle of mesosternum. Legs brownish, the tibiae testaceous.

Length, 3.85 mm; width, 2.25 mm.

Type (male), allotype (female), and 40 paratypes, from an unidentified ornamental tree, Lake Atitlán, Guatemala, July 9, 1944. Related to *C. decepta* Drake and *C. setosa* Champion but with larger tumid area of elytra and with hood fully twice as large. The hood is much smaller than in *C. globigera* Breddin or *C. unifasciata* Champion. In general aspect *C. serta* resembles more closely *unifasciata*.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1236th Meeting

The 1236th meeting was held in the Cosmos Club Auditorium, October 14, 1944, President Stimson presiding.

Program: George A. Gamow, George Washington University: *Weizsacker's planetary theory.*—It was pointed out that, although this theory had been published in Germany, the speaker's copy was one of few that had probably been received in this country because of the war. Although the published theory was incomplete in details and possibly open to certain criticisms, the speaker considered it worthy of consideration and perhaps of further development. (*Secretary's abstract.*)

Mr. A. J. Schneiderov presented an informal communication on his planetary theory.

1237th Meeting

The 1237th meeting was held in the Cosmos Club Auditorium, October 28, 1944, President Stimson presiding.

Program: J. Barkley Rosser, Cornell University: *Many-valued logics.*—The "Law of the Excluded Middle" to the effect that every exact statement is necessarily either true or false is not an absolute law of nature which cannot be transgressed. On the contrary, it is merely a habit of thought of the human race. There exist orderly systems of reasoning which flatly deny this principle. Such a system was discussed with some illustrative examples. Although this system is violently contradictory to accepted tenets of logic, it is quite consistent in itself, and could presumably be used as a basis for scientific thought. It appears to contain a mathematics of a most unfamiliar sort, which nevertheless contains certain of the standard features of the familiar mathematics. In a certain sense, one can say that this new mathematics lacks the "sharp edges" of the old, and this suggests the possibility that, when more is known of the new mathematics, it may be a useful instrument for the treatment of quantum mechanics, which seems to be a sort of physics without "sharp edges." (*Author's abstract.*)

J. Allen Hynek, Perkins Observatory, Ohio Wesleyan University: *The "science" of astrology.*—From an astronomer's viewpoint, the relatively widespread recognition of popular acceptance of belief in astrological precepts is disturbing and out of keeping with the scientific enlightenment characteristic of the present day. Recognizing the possible need for an objective demonstration of the fallacy of certain concepts held by a large part of the astrologically inclined, the writer has in his paper presented a statistical analysis of several thousand cases taken from the "American Men of Science." An analysis of the birth date frequency and the "aspects" of the planet Mercury to all other planets demonstrates by standard statistical techniques that the probability of favorable zodiacal positions of Mercury (astrologically denotes superior mental abilities) in the horoscopes of "Men of Science" is that given by the ordinary laws of chance. It is hoped that such an objective test might be useful as a classroom example. (*Author's abstract.*)

1238th Meeting

The 1238th meeting was held in the Cosmos Club Auditorium, November 11, 1944, President Stimson presiding.

Program: H. A. Marmer, U. S. Coast and Geodetic Survey: *Mean sea level.*—The level of the sea at any point is subject to the disturbing influence of various agencies, but

principally of tide, wind, and weather. Since the rise and fall of the tide is periodic, with a period of approximately 24 hours, the effect of the tide is practically eliminated by averaging the hourly heights of sea level throughout a day. When this is done, it is found that sea level varies from day to day, month to month, and year to year. Roughly it may be said that from day to day the variations are measured in feet, from month to month in tenths of a foot, and from year to year in hundredths of a foot.

From theoretical considerations, sea level should show a periodic variation dependent on the longitude of the moon's node which has a period of 18.6 years. Hence a determination of mean sea level as the average of the hourly measurements over a period of 19 years may be taken as constituting mean sea level. But for precision it is necessary to specify the period of 19 years, for the observations show a slow secular change. Along the Atlantic coast of the United States, for example, sea level for the past 20 years has been rising at the rate of about one one-hundredth of a foot per year. (*Author's abstract.*)

1239th Meeting

The 1239th meeting was held in the Cosmos Club Auditorium, November 25, 1944, Vice-President Wait presiding.

Program: E. O. Hulbert, Naval Research Laboratory: *Optics of distilled water and sea water.*—By means of a spherical scattering flask and a 12-foot absorption tube the scattering and absorption coefficients throughout the visible spectrum were measured in the laboratory of samples of distilled water, of Chesapeake Bay, and of the Atlantic Ocean.

Subtracting the absorption of pure water from that of the Bay water left a residual blue absorption due to the plankton content of the Bay. The plankton color would therefore be termed "yellow" or "amber." This combined with the red absorption of pure water caused the Bay to be green, as observed. The result supported the conclusion that the deep blue of tropical ocean areas far from land and the dark gray or green gray of high latitude sea areas far from land are due to the known scarcity and abundance of pelagic planktonic material in the respective areas.

The laboratory optical coefficients were introduced into the theoretical equations of a former paper (Journ. Optical Soc. Amer. **33**: 42–45. 1943) and the amount of daylight emerging upward from the Bay and the sea were calculated for various states of the sky ranging from clear to overcast. The theoretical values of the reflectivity of a calm surface of the sea and the Bay increased from about 0.025 to 0.055 as the cloudiness increased from zero to completely overcast. In approximate agreement with theory, values of the reflectivity of the sea and the Bay, observed in moderate weather from a boat and an airplane, were 0.02 to 0.03 for a cloudless sky and 0.05 to 0.06 for a cloudy sky. (*Author's abstract.*)

1240th Meeting

The 1240th meeting, a joint meeting with the Washington Academy of Sciences, was held in the Cosmos Club Auditorium, November 30, 1944.

Program: Robert H. Montgomery, Foreign Economic Administration: *The impact of technology on community life.*

1241st Meeting

The 1241st meeting, constituting the 74th annual meeting, was held in the Cosmos Club Auditorium, December 9, 1944, President Stimson presiding.

The Treasurer reported that the income from dues and interest on investments was $1,483.90 and that the expenditures exclusive of investments was $1,126.88, leaving a net surplus of $357.02 on ordinary expenses. The ordinary expenses were at the rate of $3.30 per member. The total estimated assets of the Society as of December 1, 1944, were $15,721.21.

The Secretaries' joint report showed an active membership as of December 1, 1944, of 339, of whom the following 29 were new members: Harold V. Argo, Mary Frances Argo, Paul F. Bartunek, E. H. Bramhall, Joseph S. Brock, Edwin Louis Crow, Gilbert H. Curl, Haskell B. Curry, Norman Davids, Charles A. Douglas, Jacques Dutka, Russell H. Goff, Laurence B. Heilprin, Fred Keller, Jr., E. H. Kennard, Myron Kirstein, Louis Landweber, Samuel Levy, Jean Sylve Mendousse, Marlin L. Miller, Martha G. Morrow, Franz H. Rathmann, Edgar O. Seaquist, William J. Sette, Alan H. Shapley, Ralph R. Shaw, Benjamin

Sussholz, Charles A. Whitten, and M. L. Zimmer.

The Secretaries reported the deaths of J. Franklin Meyer and Jesse Pawling.

Following the report of the Committee on Elections, the following officers were declared elected for the year 1945: *President*, George R. Wait; *Vice-Presidents*, C. L. Garner and Francis M. Defandorf; *Treasurer*, Francis E. Johnston; *Recording Secretary*, Kenneth L. Sherman; *Members-at-Large of the General Committee*, Walter L. Cheney, John W. McBurney, and G. B. Schubauer.

Program: Nicholas P. Setchkin, National Bureau of Standards: *The ignition temperature of liquids.*—The self-ignition temperature of a combustible mixture can be defined as the lowest initial temperature from which, under given conditions, the exothermic reaction within the mixture will raise the temperature to a point where ignition, evidenced by flame or explosion, will occur. In our tests made at atmospheric pressure, an optimum charge of the liquid, as determined by trial, was injected into a flask raised to a constant uniform temperature, the course of the reaction being indicated by temperature changes within the resulting gas-air mixture. Depending on whether ignition was obtained, tests were made at higher or lower initial temperatures until the lowest ignition threshold was determined.

The lag between the introduction of the charge and moment of ignition increased with decrease in initial temperature and, at the level of the self-ignition temperature, varied as between different liquids from a few seconds to 20 minutes.

Ignition flasks of 15,000, 1,000, and 200 ml capacity were applied in the tests with variations in details of heating and insulation. Most of the tests were made in the 1,000 ml equipment with which temperature uniformity within 1°C. was attained. Sharp distinction between ignition and non-ignition within a few degrees C. difference in initial flask temperature was observed for most liquids. Being that only the part of the heat from the ignition reaction not lost to the flask wall and surroundings is available for raising the temperature of the reacting mixture, there should be expected an increase in ignition temperature with decrease in size of ignition chamber, but this effect was not indicated as very marked for the range in size indicated above. Thus, for a sample of motor gasoline, respective self-ignition temperatures of 240°, 243°, and 248°C. were obtained in these chambers, having corresponding surface-to-volume ratios of 0.20, 0.48, and 0.83. (*Author's abstract.*)

1242d Meeting

The 1242d meeting was held in the Cosmos Club Auditorium, January 6, 1945, President Wait presiding.

The retiring President, H. F. Stimson, of the National Bureau of Standards, delivered his presidential address on the subject *The measurement of some thermal properties of water.* This address was published in this Journal (35: 201–217. 1945).

1243d Meeting

The 1243d meeting was held in the Cosmos Club Auditorium, January 20, 1945, President Wait presiding.

Program: John K. Boosahda, Naval Ordnance Laboratory: *Plastics—today and tomorrow.*—A general survey of the plastics industry was presented. A brief discussion of its growth, of types of materials available, and of the methods of processing was followed by a motion picture on molding. The most prolific period in the commercial development occurred in the last decade although the first commercial application of a plastics material dates back 75 years. Plastics were discussed under two main types, depending on the nature of the change undergone when exposed to heat: the thermosetting which undergo a chemical change and the thermoplastic which undergo a physical change. Thermosetting resins include the phenolics, the aminoplasts, and the more recent polyesters. The thermoplastic resins include the cellulosics, the vinyls, acrylics, polystyrene, and polyamides. The former are amenable to compression and transfer molding and to laminating and casting; the latter may be continuously molded by injection and extrusion. Owing to the intense development in recent years, tomorrow will bring many materials for wide use. A very interesting exhibit of plastics materials and products and an informal discussion period followed adjournment. (*Secretary's abstract.*)

1244TH MEETING

The 1244th meeting was held in the Cosmos Club Auditorium, February 3, 1945, President WAIT presiding.

Program: E. H. VESTINE, Department of Terrestrial Magnetism, Carnegie Institution of Washington: *The geographical distribution of aurora.*—A new derivation of the frequency of aurora in days per year in various geographic positions was described, as found on the basis of a revision of earlier data of Fritz, and inclusion of subsequent data of the past 70 years, for the Northern Hemisphere. Isochasms for the Southern Hemisphere were also estimated. Maps showing lines of average equal hourly frequency of aurora were found in good general correspondence with expectations indicated for average current-lines in the atmosphere during geomagnetic bays. (*Author's abstract.*)

Mr. A. J. SCHNEIDEROV presented an informal communication on the gravitational constant.

1245TH MEETING

The 1245th meeting was held in the Cosmos Club Auditorium, February 17, 1945, President WAIT presiding.

Program: DONALD H. ANDREWS, Johns Hopkins University: *Explorations near absolute zero.*—Recent developments in the technique of adiabatic cooling through demagnetization, as first applied by Giaque, have pushed the limit of attainable temperature to within 0.005° of absolute zero. The thermodynamic significance of the low temperature region is illustrated in the fact that the calculated vapor pressures of all known substances drop far below the negative hundredth power of ten atmospheres. One might expect this to be a region where no equilibrium of any kind could be attained, a graveyard of thwarted free energy. Paradoxically, in the region within a few degrees of absolute zero, there have been discovered two of the most mobile phenomena ever found, superconductivity and the superfluidity of helium. In superconductivity and its resultant persistent currents, we have one of the nearest approaches to ordered macroscopic perpetual motion, occurring, strangely enough, in what might have been expected to be the region of perpetual rest. In superfluidity, we have an example of almost a hundredfold abnormally large thermal-conductivity and small viscosity in a fluid which appears to have the ordered structure of a solid. These effects appear to be related to the quantization of energy and the resultant enhancing of phenomena especially dependent on the character of the statistics controlling the behavior of the particles. The possible use of these phenomena to provide supersensitive instrumental analysis of other phenomena at both low and high temperatures has been illustrated by the construction of a bolometer employing a superconducting filament as the radiation receiver. By using radiation sources at temperatures in the neighborhood of 25° K, it has been shown that such a bolometer will detect increments of energy of the order of 5×10^{-4} ergs per second and evidence has been obtained for the validity of the fourth power radiation law for wave lengths in the neighborhood of 100 microns. (*Author's abstract.*)

Mr. MICHAEL GOLDBERG presented an informal communication concerning the diameter of cylinders and spheres, using models in a demonstration.

1246TH MEETING

The 1246th meeting was held in the Cosmos Club Auditorium, March 3, 1945, President WAIT presiding.

Program: DOUGLAS F. WINNEK, The Winnek Laboratories, Mount Vernon: *Trivision—a direct-vision color stereograph.*—The method being developed in this laboratory uses standard photographic film, the back of which is processed, in effect forming many small cylindrical lenses. For exposure the emulsion side of the film is turned away from the camera lens. The problems and progress of development were outlined and some of the possibilities and probable uses were indicated. Sample photographs of various subjects created considerable interest and indicated real accomplishment. (*Secretary's abstract.*)

1247TH MEETING

The 1247th meeting was held in the Cosmos Club Auditorium, March 17, 1945, President WAIT presiding.

Program: A. G. McNISH, Department of Terrestrial Magnetism, Carnegie Institution of Washington: *The odograph.*—The vehicular odograph is an instrument for automatically making a map of the course followed by a

vehicle. It was developed in its experimental stages at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington under a contract with the Office of Scientific Research and Development in accordance with a directive from the Office of Chief of Engineers. Engineering the device for production was accomplished by the Monroe Calculating Machine Co. and by the International Business Machines Co., which companies later manufactured it for the Army.

The device consists of a magnetic compass, which is "followed" by a photoelectric system, and an integrating unit. Information regarding heading of the vehicle and information regarding distance traveled are fed into the integrating unit from the compass and the speedometer cable, respectively. Motion of the vehicle is mechanically resolved into north-south and east-west components by the integrator. Movements proportional to the distance travelled in each of these directions is brought up to a pair of perpendicular lead screws which drive a stylus on a map paper. In this way the course followed by the vehicle is accurately portrayed.

Experimental tests show that under normal conditions an accuracy of from one to two per cent can be expected from the device, better results not being infrequent, and even under severe operating conditions the errors remain small enough that the instrument serves many useful functions. (*Author's abstract.*)

1248th Meeting

The 1248th meeting was held in the Cosmos Club Auditorium, March 31, 1945, President Wait presiding.

Program: A. H. Stone, Geophysical Laboratory, Carnegie Institution of Washington: *Electrical networks and "squaring the square."*—This talk summarized a paper by R. L. Brooks, C. A. B. Smith, A. H. Stone, and W. T. Tutte ("On the dissection of rectangles into squares"), which appeared in the Duke Mathematical Journal, vol. 7, 1940. The problem considered is this: Can a square be dissected into a finite number of smaller square pieces, no two of which are equal? More generally, what kinds of rectangles can be dissected into unequal squares ("squared")? Rather unexpectedly, the complete solution follows from considerations of classical applied mathematics. Any "squaring" of a rectangle can be represented by a steady flow of electricity in a network, the currents being proportional to the sides of the squares. Considerations of symmetry in the network enable one to construct different "squarings" of the same rectangle, and thus to "square" a square in infinitely many different ways. It follows that a rectangle can be "squared" if and only if its sides are commensurable. "Squared" rectangles can have as few as 9 square pieces, but no fewer. A square can be dissected into 26 unequal squares, possibly fewer. (*Author's abstract.*)

Mr. L. B. Tuckerman presented an informal communication on adding strength to structural parts by cutting away material.

1249th Meeting

The 1249th meeting was held in the Cosmos Club Auditorium, April 14, 1945, President Wait presiding.

Mr. Silsbee, Chairman of the Joseph Henry Lecture Committee, introduced John von Neumann, of the Institute for Advanced Study, Princeton, who delivered the fourteenth Joseph Henry lecture, *Causality, statistics, and quantum mechanics.* It is expected that this lecture will be published in this Journal.

1250th Meeting

The 1250th meeting was held in the Cosmos Club Auditorium, April 28, 1945, President Wait presiding.

Program: William F. Brown, Jr., Naval Ordnance Laboratory: *Ferromagnetic domains.*—The Weiss "molecular field" theory explained the large magnetization of ferromagnetic materials but predicted spontaneous magnetization even in zero field. To overcome this difficulty, Weiss postulated that the material really is spontaneously magnetized over microscopic regions or "domains," which in zero field are magnetized in different directions. Despite quantum-theory improvements on Weiss's theory, domains must still be postulated.

At small fields, the domains are magnetized along "directions of easy magnetization" determined by crystalline anisotropy; the field causes a larger volume to be magnetized in some of these directions and a smaller volume in others. At large fields, the spontaneous magnetization rotates toward the field direction. The second stage is reversible and therefore

easily handled theoretically. The first stage is more difficult to interpret. Experiments on the Barkhausen effect, powder patterns, and alloys under tension suggest that one domain grows at the expense of another by displacement of the "wall" between them. A theoretical study of the "wall" supports this idea. Walls undergo small displacements reversibly, but ultimately they reach unstable positions and move irreversibly through finite distances; this is the mechanism of the Barkhausen effect and hysteresis. (*Author's abstract.*)

Mr. A. H. Mears presented an informal communication on an instrument developed for obtaining data for statistical study and its use in connection with a wind turbine for generating power.

1251st Meeting

The 1251st meeting was held in the Cosmos Club Auditorium, May 12, 1945, President Wait presiding.

Program: Sterling B. Hendricks, Bureau of Plant Industry, Soils, and Agricultural Engineering: *Photoperiodic flowering response of plants.*—Floral development in plants as influenced by length of day was discussed in detail and illustrated by examples within the experience of the audience. Results recently obtained by H. A. Borthwick, M. W. Parker, N. J. Scully, and the speaker were presented. Spectroscopic equipment used to determine the action spectrum for floral initiation in Biloxi soybean was described.

The following theory consistent with past observations was advanced: A material forming in the chloroplasts during the dark period diffuses from the leaf to the growing point and, between certain concentration limits, causes floral development. Light absorbed by chlorophyll partially destroys this material at its source by sensitized oxidation. At high concentrations, such as produced in long-day plants under short-day conditions, the material inhibits flowering. Continuous illumination of a long-day plant reduces the concentration of the material to the critical range. This range is attained in short-day plants only when the night is adequately long. (*Author's abstract.*)

1252d Meeting

The 1252d meeting was held in the Cosmos Club Auditorium, May 26, 1945, President Wait presiding.

Program: William B. Kouwenhaven, Johns Hopkins University: *Electric shock—physiological manifestations and treatment.*—The speaker outlined the problems relating to electric shock, discussed the effects of electric currents passing through the body, and described methods of resuscitation. The importance of immediate application of artificial respiration methods and their uninterrupted and continued use was stressed. The method of applying artificial respiration atop the poles of power lines was given and illustrated in some detail. Results were given of comparisons between this method and the normal method by which the patient is first brought down the pole and placed prone on the ground. (*Secretary's abstract.*)

Mr. L. B. Tuckerman presented an informal communication relating to the equation of a curve like that at the seams of the cover of a baseball.

Kenneth L. Sherman,
Recording Secretary.

BACK ISSUES OF JOURNAL WANTED

During the past several years the Custodian and Subscription Manager of Publications has received from various members of the Academy many numbers of the Journal that were no longer needed by them. These contributions have made it possible to assemble several complete sets. At the present time there is urgent need for those issues of the Journal in Volumes 1 to 10, inclusive. Accordingly, members who may have any such numbers that they no longer wish to keep are urged to send them to Frank M. Setzler, Custodian and Subscription Manager, U. S. National Museum, Washington 25, D. C.

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This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued monthly, on the fifteenth of each month. Volumes correspond to calendar years.

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JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOLUME 35 DECEMBER 15, 1945 No. 12

LINGUISTICS.—*Six common Navajo nouns accounted for.*[1] JOHN P. HARRINGTON, Bureau of American Ethnology.

The Navajo Indians are North America's largest tribe and occupy the biggest Indian reservation in the United States, which is situated in the States of Arizona and New Mexico. A half dozen of some of the very most widely known words of the Navajo language, each with a new derivation or connection, are here presented.

The Navajo word for bean of any kind, *Phaseolus vulgaris* L. and other spp., is nàa'òłí. To one conversant with the far-swung forms of Spanish frijoles, beans, singular frijol, bean, in several Indian languages, the source of this Navajo word as Spanish frijoles seems likely. If we accept this postulation, another word for bean must have obtained in Navajo in pre-Spanish times. The name of bean in all the languages surrounding the Navajo has been looked into.

The common Navajo term for blanket is pèeltléí, sometimes pronounced péeltlátí. This term not only is used by the Navajo for blanket but is the common term for the famous Navajo blanket, which in English is sometimes called a blanket and sometimes a rug, and for the making of which the Navajo Indian tribe is known all over the world. This word is nothing short of Spanish fresada, blanket, which is the ordinary Spanish word for blanket, in corrupted form, pèeltlátí even retaining the three syllables of the Spanish. This brings out the interesting fact that not only is the Navajo blanket largely due to Spanish acculturation but also that its name is derivative to Spanish.

The Navajo call a white man Pìlìkáanà. This is from Spanish Americano, American, with a twist in meaning. United States American is mostly meant, a Mexican being termed apart. Several other terms for United States American based on soldier dubbings are still more or less in use, while calling United States American by the word meaning enemy, as is done in several Apache languages, is not the practice in the Navajo language of today and may never have been.

The center of Navajo craftsmanship is the blanket; the supply for this center is tìpé, sheep. Codescendant languages show clearly that this is in origin the name of the wild sheep now extended in meaning to apply to the tame one. The original meaning was clearly the bleater.

Navajo kàt, juniper, *Juniperus monosperma* (Engelm.) Sarg., is also a very common word as regards its designation. All the Navajo country of lower levels is dotted with kàt, juniper trees, and occasionally one sees a juniper tree which has been struck by lightning. This Navajo word is patently the same as the neighboring Laguna Keresan k'á'nì, juniper. Since the Navajo are well known to have come from the north, the transmission of the name may well have been in the direction from the Laguneño to the Navajo. One should distinguish Navajo k'àt, now, also of grave intonation, which has the same start as the Laguna Keresan word. In Navajo kà'nìJìi, white spruce, literally pull-out juniper (referring to the needles being easy to pull out), an earlier *katnijii has had its *t* smothered, turned into alif.

Navajo xòoGàn refers to the native-style house, hogan, while khìn means a rectangular house. Sometimes one hears what might be written x^wòoGàn. The word xòoGàn means in etymology a dwelling-place, being composed of xòo-, referring to area, and -Gàn, a stereotyped verb meaning to dwell. Chiricahua khòoGạ̀, native house, is absolutely the same word with the same meaning as the Navajo has.

[1] Received September 21, 1945.

BOTANY.—Kokonoria, *a new genus of Plantaginaceae from Tsinghai Province, China.*[1]

YI-LI KENG and KWAN-HOU KENG, National Central University, Chungking, China. (Communicated by EGBERT H. WALKER.)

In the summer of 1944 the authors had an opportunity to undertake an expedition to the northwestern part of China. They went to Lake Kokonor in Tsinghai Province and to Labrang in Kansu Province with a view to investigating the grazing lands and the forage plants of these regions for the National Research Bureau of Animal Industry, China. During this survey they collected nearly a thousand numbers of botanical specimens, which are now deposited in the herbarium of the National Central University. Naturally there were many novelties found in these two botanically very little known regions. One of these specimens represents a new genus of Plantaginaceae, described herewith. Although the study of the whole collection is far from complete, it seems desirable to publish this new genus at the present time.

The authors wish to express here their gratitude to Dr. Vougi Tsai and Prof. Tieh-tsai Chang, the director and vice-director, respectively, of the Bureau, through whose zealous recommendation, kind assistance, and financial maintenance the authors were able to conduct the expedition successfully.

Kokonoria[2] Keng & Keng f., gen. nov.

Flores hermaphroditi, zygomorphi, trimeres, receptaculo brevissime cupulari, juventate tenuiusculo; calyx gamosepalus, persistens, bilobatus, lobis membranaceis, lateraliter positis, saepissime antice vix conjunctis; corolla sympetala, ad maturitatum subcoriacea sed decidua, breviter trilobata, lobis deorsum imbricatus, duobus anticis minoribus, tubo quam limbo multo longiore, interdum ad fauces constricto, arcte ad marginem receptaculi cupularis affixo; stamina 2 (tertium anticum absens), inclusa vel vix exposita, ad vel infra incisiones duas laterales inter corollae lobis inserta; antherae ad maturitatem inversum V-formae, subsessiles vel a filamentis brevissimis fultae, thecis duabus divergentibus, longitudinaliter dehiscentibus, distinctis vel apice confluentibus; pollen ellipsoideum, longitudinaliter 3-sulcatum; discus perigynus, annularis sed serius utrimque lobis duobus elevatis accrescentibus appendiculatus; ovarium liberum, breviter stipitatum, biloculare, loculis 1-ovulatis; stylus unicus, terminalis, dimorphus, aut brevis inclususque aut longior exsertusque, stigmate terminali, paulum bilobulato; ovula linearis, anatropa, ex apice loculi ovarii pendula; fructus drupaceus, bractea atque lobis duobus calycis subtentus, biseminalis, mesocarpio textura spongiusculo; semina dorsaliter compressa, anguste oblongilanceolata, exalbuminosa, in sectione semicircularia, testa tenui, laevi; embryo rectus, radicula brevissima, superiore, cotyledonibus oblongis, subcarnosis. Herbae perennes, humiles, stoloniferae; rhizomata crassa, foliorum basibus emarcidis fibrillosis vestita; folia radicalia, alternata, simplicia, integra, inferne attenuata sed basi in structuras membranaceas vaginis similes dilatata; flores parvi, bracteati, desiccatione nigri, in scapis axillaribus quam foliis brevioribus spicati, bracteis magnis, in anthesi praeter eas margines liberas lateri antico receptaculi cupularis inferne plus minusve adnatis. Species unica, provinciam Tsinghaii, prope mare conclusum Kokonoris habitans.

Flowers hermaphrodite (always so?), zygomorphic, trimerous, the receptacle shortly cupular, rather thin in texture when young (as also the calyx); calyx gamosepalous but usually much less united in front, persistent, laterally 2-lobed, the anterior lobe entirely wanting but replaced in the corresponding position by a large bract adnate below to the cupular receptacle but with free margins; corolla sympetalous, thickened in anthesis but deciduous in fruit, shortly 3-lobed, the posterior lobe larger, descending-imbricate, the tube much longer than the limb, firmly attached to the margin of the receptacle, sometimes constricted at the throat; stamens 2 (the anterior stamen wanting), included or scarcely exposed, inserted at or just below the two lateral notches between the corolla lobes; anthers inverted V-shaped at maturity, subsessile or with short filaments,

[1] Received October 26, 1945.

[2] From "Kokonor," which means in Mongolian the "blue sea."

the two cells divergent, dehiscing lengthwise, distinct or confluent at apex; pollen grains ellipsoidal, longitudinally 3-furrowed; disk perigynous (its attachment seen in a young flower a little below that of the corolla tube), annular but later appendaged on both sides with two prominent elevated lobes; ovary superior, shortly stipitate, bilocular, each locule 1-ovuled; style 1, terminal, dimorphic (either short and included or slender and exserted) with a terminal slightly 2-lobed stigma; ovule linear, anatropous, pendulous from the apex of the ovary cell; fruit drupaceous, subtended by a bract and two calyx lobes, 2-seeded, the mesocarp somewhat spongy in texture; seeds dorsally compressed, narrowly oblong, exalbuminous, semicircular in section; testa thin, smooth; embryo straight, with a short superior radicle and two somewhat fleshy cotyledons. Perennial stoloniferous low herbs with simple stout rhizomes, which are covered with emarcid fibrillose leaf bases; leaves radical, alternate, simple, entire, attenuate below but broadened at base into membranous sheathlike structures; flowers small, bracteate, spicate on axillary scapes shorter than the leaves. One species endemic near Lake Kokonor, Tsinghai Province, China.

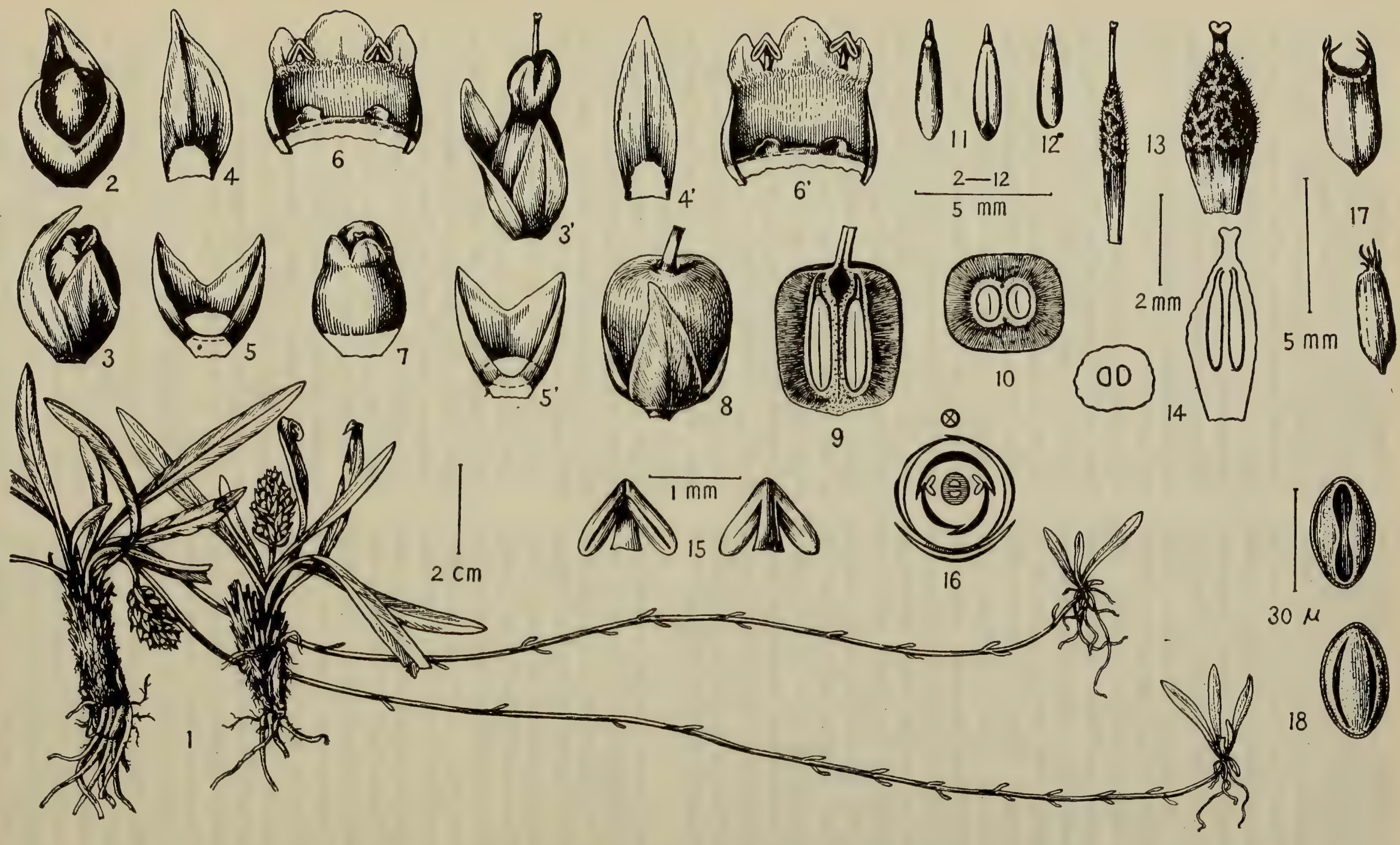
Heretofore only three not closely related genera, *Plantago*, *Littorella*, and *Bougueria*, were known in the Plantaginaceae, all acaulescent herbs with radical leaves and axillary scapes. The genus here described is an isolated one, differing from the others in having (1) perigynous flowers with an annular disk giving off two lateral accrescent lobes, (2) subsessile anthers with divergent anther sacs, (3) solitary linear ovules pendulous from the tip of the ovary cells, (4) drupaceous fruits with a 2-celled pyrene, and (5) dorsally compressed but not peltate seeds without endosperm. Comparatively it shows an affinity to the gènus *Bougueria*, which is polygamous, monotypic, and endemic on the high Andes. The 3-merous corolla and the 2-membered androecium of *Kokonoria* is also found in *Bougueria*, but *Kokonoria* differs from that in the 2-lobed calyx, bilocular ovary, and the straight embryo, *Bougueria* having a calyx of four linear sepals, an ovary unilocular, and an embryo curved around the albumen.

According to Dr. S. Ting, professor of geography at National Central University and a specialist on pollen grains, the ellipsoid, 3-furrowed pollen of this genus is of a common type found in several families, such as Scrophulariaceae and Umbelliferae. He says it is quite different from that of *Plantago*, which has rounded many-pored pollen grains. It seems also very worth while to compare the pollen of *Kokonoria* with that of *Littorella* and *Bougueria*, but, unfortunately, the material and literature now available here are inadequate for study of this kind.

It seems very probable that the 4-merous flower of the cosmopolitan genus *Plantago* is formed through the reduction of the posterior odd sepal and the union of the posterior two corolla lobes from a 5-merous sympetalous type such as the Scrophulariaceae. A comparison of the floral structure of *Plantago* with that of *Veronica* indicates this conception to be correct. As a result of this reduction, the four sepals are placed diagonally and the four corolla lobes crosswise. When the anterior two sepals of this 4-merous flower are further completely united and the anterior petal suppressed, a 3-merous flower is evolved such as is found in *Kokonoria*. There is, however, in *Kokonoria* a tendency toward reduction to a 2-merous structure, for the anterior sepal and anterior stamen are entirely reduced. A further reduction in the union of its anterior two corolla lobes into a single segment would bring the flower to a complete dimerous state. Hence, the genus *Kokonoria* is evidently much more advanced than *Plantago* is the reduction of its floral structure. Furthermore, the development of a perigynous flower, annular disk, and exalbuminous seeds also shows an advancement of *Kokonoria* over the other three genera of Plataginaceae in the evolutionary scale. But the evolutionary development of Plantaginaceae apparently culminates in the production of a dimerous flower with inferior or half-inferior ovary. A plant with such a floral structure has been found in *Circaea*, which reaches the climax of development in Onagraceae, but it is still to be discovered in the plantain family.

Kokonoria stolonifera Keng & Keng f., sp. nov.

Herbae perennes, glabrae; rhizomata erecta, 1.5–3 cm alta, 1 cm crassa (foliorum basibus persistentibus fibrillosis includentibus); stolones axillares, graciles, circ. 20–30 cm longi, foliis squameis reductis instructi, in plantas juveniles parvas terminantes; folia rosulata,



FIGS. 1–18.—*Kokonoria stolonifera* Keng & Keng f., drawn from type: 1, habit; 2, posterior view of a plumper flower; 3, lateral view of same; 3′, lateral view of a thinner flower; 4, 4′, interior views of bracts, lower unshaded part showing degree of adherence to cupular receptacle and calyx tube; 5, 5′, calyces with cupular receptacle below dotted circle; 6, 6′, interior views of expanded corollas showing stamens and annular disk with its appendages, part below dotted line belonging to cupular receptacle; 7, plumper flower with bract and calyx removed, showing corolla inserted on cupular receptacle as a whole; 8, fruit with persistent bract, calyx, and style-remnant; 9, 10, longitudinal and cross section of fruit; 11, posterior and anterior views of seed; 12, embryo showing short superior radicle and two cotyledons; 13, two pistils, the one slender from a thinner flower, the other stout from plumper flower; 14, cross and longitudinal section of pistil; 15, anterior and posterior views of stamen; 16, floral diagram; 17, side (above) and face (below) views of a stone; 18, two views of a pollen grain. 4, 5, and 6 are drawn from plumper flowers; 4′, 5′, and 6′ are from thinner flowers.

obscure viridula, plus minusve carnosa, anguste lanceolata, 15–55 mm longa, 5–6 mm lata, inferne attenuata et petiolis similia, costa media infra prominenti, supra depressa; pedunculi compressiusculi, circ. 1.5 cm longi, 1 mm lati sed sursum versus apicem paulum dilatati; spicae pauci- vel pluri-florae, 1–2 cm longae, circ. 1 cm crassae, erectae vel ad maturitatem pendulae; bractea straminea, membranacea sed dorso firmula, oblongi-lanceolata, 7–8 mm longa, 2–3 mm lata, integra, acutiuscula vel obtusa; flores subsessiles, conferti vel inferiores remoti; calycis tubus saepissime altitudine inaequalis, in latere antico circ. 1.5 mm altus et in postico 2.5 mm, lobis ovatis, in anthesi late patentibus, 3–3.5 mm longis, 3 mm latis, margine late scariosis sed costa media viridulis, prope apicem crispe ciliolatis; corolla juvenilis membranacea albidaque, aetate subcoriacea puniceaque, tubo circ. 5 mm longo, 3 mm in diametro, extus glabro sed intus ad fauces puberulenti, desiccatione nigro, irregulariter rugoso, posteriore plus minusve inflato, lobis erectis, obtusis, ovatis vel subrotundis, colore quam tubo siccano clarioribus, uno postico quam duobus anticis longiore sed multo latiore, interdum emarginato, 1–1.5 mm longo, 1.5 mm lato; disci lobi oblongi, cuneati, vel quadrangulares, 1.5–3 mm longi, 1–2 mm lati, ad maturitatem subcoriacei, irregulariter divisi vel erosi, fusci-brunnei, super ovarii stipitem incumbentes; staminis filamentum brevissimum, usque ad 1 mm longum; antherae flavidi-brunneae, thecis circ. 1 mm longis; pollen 30–40μ longum, 13–23μ latum, sulcis 3 profundis longitudinalibus pervagatum, tenuissime sed irregulariter granulare; ovarium juvenile lateraliter compressum, ellipticum glabrumque, serius lineari-oblongum vel fusiforme, circ. 3.5 mm longum (stipite glabro includente), 1–2 mm crassum, superne puberulum et irregulariter rugosum; stylus sive crassus circ. 0.5 mm sive gracilis usque ad 5 mm longus, stigmate capitulato, laevi, minute bilobulato; fructus globularis, 5–7 mm longus, 3–5 mm in diametro, glaber, fusci-brunneus, stylo vel eius residuo persistente superatus, pericarpio siccano, circ. 1.5 mm crasso, pyrena lignosa, nigrescente, tereti sed leviter lateraliter compressa, 4–5 mm longa, 2 mm lata (in latere latiore), basi breviter constricta, apice crescente (in aspectu laterali), in margine antero-posteriore fibris erectis lignosis fimbriata; semen albidem, 4 mm longum, 1 mm latum, extrinsecus canaliculo tenui longitudinali medio sulcatum; embryo semine paulum brevior, cotyledonibus plano-convexis, ultra 3 mm longis.

Perennial glabrous herbs; rhizomes upright, 1.5–3 cm tall, about 1 cm thick including the straw-colored fibrillose leaf bases; stolons slender with scalelike leaves, about 20–30 cm long, terminating in small plantlets; leaves several in a rosette, dark green, more or less fleshy, narrowly lanceolate, 1.5–5.5 cm long, 0.5–0.6 cm wide, acute, attenuate and petiolelike below, the midrib prominent beneath, depressed above; peduncle 2-edged, about 1.5 cm long, 1 mm wide but somewhat broadened toward the apex; spikes several- to many-flowered, 1–2 cm long, about 1 cm. thick, erect or pendulous at maturity; bract stramineous, membranous but somewhat firm dorsally, oblong-lanceolate, 7–8 mm long, 2–3 mm wide, entire, acutish or obtuse; flowers subsessile, crowded or the lower ones somewhat remote; calyx tube (including the cuplike receptacle) usually asymmetric, about 1.5 mm on the anterior and 2.5 mm long on the posterior side, the lobes ovate, wide open in anthesis, 3–3.5 mm long, 3 mm wide, broadly scarious with prominent green midribs, crinkled-ciliolate near the apex; corolla membranous and whitish when young, subcoriaceous and pinkish when mature, the tube about 5 mm long, 3 mm across, glabrous outside, puberulent at the throat within, irregularly wrinkled when dry, dorsally more or less inflated, the lobes erect, obtuse, ovate or somewhat rounded, lighter in color than the tube (seen in dry specimens), the anterior two slightly shorter but much narrower than the posterior one, which is sometimes emarginate, 1–1.5 mm long, 1.5 mm wide; disk lobes oblong, cuneate or quadrangular, 1.5–3 mm long, 1–2 mm wide, irregularly cleft, subcoriaceous at maturity, dark brown, pressed against the stipe of the ovary; filaments from very short to 1 mm long; anthers yellowish brown, with sacs about 1 mm long; pollen 30–40μ long, 13–23μ wide, longitudinally traversed with three deep furrows, the exine finely but irregularly granular; ovary laterally compressed, elliptic and glabrous when young, later becoming linear-oblong to fusiform, about 3.5 mm long (including the glabrous stipe), 1–2 mm thick, puberulent and irregularly wrinkled; style either stout, about 0.5 mm long, or slender

and up to 5 mm long; stigma capitulate, smooth, bilobed; fruit globular, 5–7 mm long, 3–5 mm across, glabrous, dark brown, surmounted by the persistent style or its remnant, the pericarp dry, about 1.5 mm thick; stone (pyrene) woody, nigrescent, terete but somewhat compressed laterally, 4–5 mm long, 2 mm wide (the broader side), shortly constricted at base, crescent at apex (in side view) with erect wood fibers on the anterior-posterior margins; seed whitish, 4 mm long, 1 mm wide, outwardly sulcate with a fine longitudinal median groove; embryo slightly shorter than the seed, with planoconvex cotyledons over 3 mm long.

Type in the Herbarium of the Department of Biology, National Central University, Chungking, China, collected on the exposed bare ground of the steppe, near the ruined city Ch'a-han-chêng, (察汗城), about 30 miles east of Lake Kokonor, Huan-yüan-hsien (湟源縣), formerly known as Tan-kê-erh (丹噶爾), Tsinghai Province, August 10, 1944, by Y. L. Keng and son (no. 5286).

There are two kinds of flowers (see Figs. 3 and 3′) in this species, one near the base of the spike having plumper corollas, subsessile anthers, and short included styles, the other on the upper part with rather slender corollas constricted at the throat, very short but distinct stamen filaments, and longer exserted styles. Though each flower form possesses two well-developed stamens and a pistil, all the fruits seen are found to have a rather long style or its remnant at the apex. Therefore, further examination is needed to decide whether the flower with a short included style is fertile. It is quite certain, however, that the flowers are all entomophilous, since the anthers never exceed the erect corolla-lobes which would be necessary for wind pollination. The zygomorphy of the flower is shown not only by the corolla with three unequal lobes but also by the calyx, which usually has an unequal union of the two laterally placed sepals.

The bract of a rather young flower is dorsally more or less adherent below to the anterior side of the very short cupular receptacle including the calyx tube. But the short calyx tube is sometimes also found to be distinctly exposed in front beyond the adnate portion of the bract. No matter how much the adherence of the bract, the margins are always quite free from either the receptacle or the calyx. If there were no such free margins present, the bract would be easily mistaken in morphology for an anterior lobe of the calyx, which, like the anterior stamen, is entirely suppressed in this species. The corolla is at first distinctly perigynous and very thin in texture but becomes much thicker or even coriaceous at maturity and appears to have increased its size and thickness downward so much that it seems thenceforth to be hypogynous. The deciduousness of the corolla is perhaps caused by the protrusion of the enlarged fruit, which ruptures the corolla and causes it eventually to fall off. Another peculiarity is that the annular disk, which is also perigynous with an attachment a little below the corolla, gives off on both sides two large thick and variously shaped appendages during its development from youth to maturity.

ENTOMOLOGY.—*Synoptic revision of the United States scarab beetles of the subfamily Dynastinae, No. 1: Tribe Cyclocephalini.*[1] LAWRENCE W. SAYLOR, Research Associate, California Academy of Sciences.

The important subfamily Dynastinae has for some time been relatively neglected, taxonomically speaking, and only in the past few years have new species been described or the larval characters of many species better characterized. In all collections I have seen, numerous United States species are grossly misidentified, and it is hoped that the present papers will help to rectify this condition.

Ritcher's paper (1944) is an excellent contribution to the immature stages of these insects. His title, however, *Dynastinae of the United States*, is very misleading, because this paper includes only a small proportion of the described United States species, and only those adults are mentioned of which he had larvae; thus, of the 18 described genera and 119 United States species listed as valid in Arrow's latest catalogue (1937), Ritcher treats the larvae and adults of but 12 genera and 20 species. Even though a

[1] Received August 13, 1945.

number of these 119 names are not valid, many of them are important and well-known species and must be considered. Also, two generic and three specific names that Ritcher uses have been changed; regardless of these taxonomic errors, the paper is very important from an economic standpoint.

Casey's studies in this group have greatly enlarged our synonymy because of his practice of naming trifling variants, but at the same time his Memoirs (1915) gave more detailed information and pointed out more new characters and relationships than had any of his predecessors or contemporaries, including Horn and LeConte; it is indeed too bad that Colonel Casey's idea of a "species" was not exactly that of the vast majority of coleopterists; otherwise his work in this family would have stood for some time. I have had the privilege of studying and dissecting all of Casey's scarab types through the courtesy of Dr. A. Wetmore and Dr. E. A. Chapin, of the U. S. National Museum, to both of whom I am indebted for many favors in the past.

The Dynastinae in most instances possess well-chitinized genitalia, and the characters of those of the male are very helpful in specific determination, and wider use should be made of them. Indeed, in such difficult genera as *Cyclocephala*, it is necessary to dissect and compare the male genitalia in order properly to place many of the troublesome variants.

Dynastine bibliography is now so long and detailed in most genera that very little is to be gained by citing every unimportant reference, as this has already been done in Arrow's catalogue of world Dynastinae. Thus, in the present series of papers, of which this is the first of four, only the important bibliographical references have been selected and a list of those cited is given at the end of each paper. Keys to all tribes and genera will be given in the last paper of the series.

KEY TO THE GENERA

1. Ligula strongly convex, apex very deeply incised and declivous; clypeus long and parabolic, without front angles, and very obtusely angulate at midapex; mandibles very long and slender and exposed beyond clypeal apex; male front claw enlarged. *Ancognatha* Erichson

   Ligula variable, but never more than slightly emarginate, never incised; clypeus of different shape; claws variable 2
2. Color black, mandibles broad, rounded externally and either exposed beyond or hidden beneath clypeus; clypeus *either* trapezoidal and short with apex not reflexed *or* clypeus longer and strongly reflexed, with clypeal suture entirely obsolete and front coarsely cribrate and convex 3

   Color testaceous, often mottled with brown cloudings (only *very* rarely blackish); clypeal suture always strongly indicated; mandibles extended beyond clypeal apex and very slender 4
3. Clypeus very strongly reflexed apically and faintly emarginate; clypeal suture entirely lacking; base of ligula very deeply and triangularly emarginate, apex very narrow; all claws both sexes simple; first segment of hind tarsus longer than next two combined; Arizona . . . . *Coscinocephalus* Prell

   Clypeus faintly emarginate apically and not reflexed; clypeal suture strong; ligula flattened at base, apex very broad; front claws of male enlarged; first segment of hind tarsus a little longer than second. *Dyscinetus* Harold
4. Head very broad, nearly three-fourths width of thorax, clypeus very long and flat, sides parallel and apex subrounded; Central America and ?Texas . . . . . *Aspidolea* Bates

   Head definitely less than half as wide as thorax; clypeus variable but never exactly as above (if long, no longer than front). *Cyclocephala* Latreille

Genus **Ancognatha** Erichson

Ancognatha Erichson, 1847, p. 97; Lacordaire, 1856, p. 398; Bates, 1888, p. 297; Casey, 1915, p. 124.

Only a single species occurs in the United States, but it is quite variable in color, especially the Mexican examples.

Ancognatha manca LeConte

A. manca LeConte, 1866, p. 382; Bates, 1888, p. 335; Arrow, 1911, p. 169; Casey, 1915, p. 127.
A. aequata Bates, 1888, p. 297, pl. 17, fig. 12.
A. perspicua Casey, 1915, p. 126.
A. zuniella Casey, 1915, p. 127.
A. durangoana Casey, 1915, p. 125. (New syn.)
A. laevigata Bates, 1888, p. 297. (New synonymy.)

I have examined specimens from central Mexico to Arizona and New Mexico. Varies in color from deepest black, to black with rufocastaneous elytra and legs, to castaneopiceous with testaceous legs, scutellum, and thoracic margins; most Arizona specimens are the last phase. The length varies from 15 to 19 mm. The very tumid, deeply cleft ligula will readily place the species.

Genus **Coscinocephalus** Prell

Coscinocephalus Prell, 1936, p. 145.
Anoplocephalus Schaeffer, 1906, p. 259. (Preocc.)

Our single species from Arizona is the sole representative of this genus.

Coscinocephalus cribrifons (Schaeffer)

Anoplocephalus cribrifons Schaeffer, 1906, p. 260; Casey, 1915, p. 124.

The maxilla of this uncommon species is entirely unarmed (no teeth), and the mentum (ligula) is very strongly acuminate apically as in *Cyclocephala hirta*, but differs in the base in *Coscinocephalus* being deeply and triangularly depressed at base. The long and coarsely cribrate clypeus, which is strongly reflexed and faintly emarginate apically, also distinguishes the genus.

Genus **Dyscinetus** Harold

Dyscinetus Harold, 1869, p. 123; Casey, 1915, p. 165; Prell, 1936, p. 147.
Chalepus Macleay, 1819, p. 149; Lacordaire, 1856, p. 403.
Palechus Casey, 1915, p. 174.

Arrow lists 20 species of this purely American genus, which ranges throughout the Americas and the West Indies, and many of them are of considerable economic importance.

KEY TO THE SPECIES

Pygidium entirely and coarsely cribrate; clypeus finely punctured and smooth; eastern United States, west to Texas. . . . *morator* (Fabricius)
Pygidium coarsely to somewhat coarsely but not densely punctured; spaces between punctures highly polished and smooth; clypeus coarsely and transversely rugose; California and east to New Mexico and south to Mexico and West Indies. . . . . *picipes* (Burmeister)

Dyscinetus morator (Fabricius)

Scarabaeus morator Fabricius, 1799, p. 24; Arrow, 1937, p. 17. (*Dyscinetus*.)
Dyscinetus trachypygus Burmeister, 1847, p. 79; Bates, 1888, p. 312; Casey, 1915, p. 171; Ritcher, 1944, p. 21 (larva).
Dyscinetus discedens Casey, 1915, p. 171.
Dyscinetus borealis Casey, 1915, p. 171.

This is the common rice beetle which ranges through the mid-eastern States and southern States west to Texas and Kansas. The larvae feed beneath the sod and occur also in compost heaps or near pigpens (Phillips and Fox).

Dyscinetus picipes (Burmeister)

Chalepus picipes Burmeister, 1847, p. 79.
Chalepus obsoletus LeConte, 1854, p. 222. (New synonymy.)
Chalepus geminatus Jacquelin du Val, 1856, p. 127.
Dyscinetus ebeninus Casey, 1915, p. 169.
D. subquadratus Casey, 1915, p. 166.
D. gilianus Casey, 1915, p. 168.
D. laevissimus Casey, 1915, p. 167.
D. puncticauda Casey, 1909, p. 282; Casey, 1915, p. 169. (New synonymy.)
D. punctipes Bates, 1888, p. 312.

Specimens have been examined from California, Colorado, Arizona, New Mexico, and Kansas, as well as from Mexico and the West Indies (Puerto Rico, Cuba, Guadeloupe, and Dominican Republic). The pygidial punctuation is highly variable and is usually coarser and sparser in the male, with the female often rather finely and sparsely punctured. In some New Mexican males the pygidium is very cribrately and contiguously punctured at the sides, as is similar in some Mexican males where the pygidium is entirely, coarsely, cribrately, and contiguously punctate over the entire disc; the male genitalia and all other specific characters are identical, thus showing how unreliable the pygidial puncturation (on which many species have been based in the past) really is. The pygidial disc is usually glabrous with long hairs along the apical margin.

Genus **Cyclocephala** Latreille

Cyclocephala Latreille, 1829, p. 552; Lacordaire, 1856, p. 398; Bates, 1888, p. 299; Casey, 1915, p. 112, 134; Arrow, 1937, p. 7 (lists additional subgenera).
Spilosota Casey, 1915, p. 112.
Ochrosidia Casey, 1915, p. 112.
Dichromina Casey, 1915, p. 112.

This truly American genus contains over 200 described species, as well as many undescribed forms. The species are very difficult to separate by means of the older descriptions, and even present-day descriptions must be very long and exceptionally detailed properly to place the species. Many species feed on pollen in the flowers of Arums and become imbedded in the viscous pollen at the bottoms of the spathes; so far as I know, *C. dimidiata* Burmeister is our only species possessing this habit, and it occurs commonly in the flowers of the jimsonweed (*Datura*) in California (Van Dyke and Saylor). One Central American species (*prolongata*

Arrow) has the head and thorax very long and exceptionally narrowed anteriorly, apparently an adaptation for feeding in the blossoms of a narrow flower.

Our American (United States) species have been worked over by Casey in great detail, who described many variants, so that we have 39 names for what I consider to be only 10 valid species. In this study I have examined nearly 3,000 specimens in many collections during the past eight years.

The male tarsi are always enlarged in this genus and the female claws are small and simple. The male genital characters are good, if carefully studied and compared.

KEY TO THE MALES

(Check male genitalia in doubtful specimens)

1. Front tibia *unidentate* (smooth behind apical tooth); dorsally with fine sparse hairs; clypeus parabolic and angles not indicated; Arkansas................*knobelae* (Brown)
   Front tibia always bidentate or tridentate *or* if apparently unidentate then the head black and clypeus narrow and nearly impunctate apically...............................2
2. Front tibia peculiarly *bisinuate* externally (Fig. 1, *n*); head black; clypeus very narrow and rather long, apical half *smooth* and impunctate, apex strongly reflexed and subrounded, angles narrowly rounded; apparently glabrous above; thorax with two large piceous spots before midapex and a small piceous spot each side of disc; Alabama, Mississippi, and Georgia..*setidiosa* LeConte
   Front tibia bidentate or tridentate; other characters not as above.....................3
3. Clypeus trapezoidal, apex subrounded and reflexed, angles very broadly rounded; disc *very smooth* and very sparsely and exceedingly finely punctured, to nearly impunctate; thorax and elytra with sparse erect hair, that of pygidium much longer; upper tooth of front tibia obsolete; Georgia, Alabama, Florida................*puberula* LeConte
   Clypeus variable but always strongly sculptured...................................4
4. Large claw front tarsus very strongly and widely cleft and upper tooth nearly as wide as apical one but much shorter in most cases (Fig. 1, *l*); tarsi subequal to or shorter than tibia; head black and elytra testaceous, otherwise rufous; antennal club *ovate*, only as long as segments 3–7 of stem; Mississippi west to California, south to South America. *dimidiata* Burmeister
   Large claw always much more narrowly cleft or claw entire.........................5
5. Clypeus very strongly narrowed apically, apex narrowly reflexed; clypeal suture very strongly bisinuate, entire disc very grossly scabrose and entirely punctured; antennal club shorter than stem; fresh specimens with moderate to dense dorsal hairs; ligula strongly narrowed apically and apex pointed (Fig. 1, *w*); California to Texas. *hirta* LeConte
   Clypeus not as above; ligula variable but never actually pointed apically................6
6. Clypeus fairly long, sides often nearly straight behind and only faintly convergent apically, apex subtruncate and very strongly and highly reflexed; disc very coarsely and transversely, rugosely wrinkled; antennal club large and longer than the stem; California, Lower California, and Arizona. *longula* LeConte
   Clypeus not as above and disc never coarsely and transversely wrinkled...............7
7. Color usually dark castaneopiceous, the thorax lighter; above densely hairy; clypeus long and flat, hardly narrowed at front, apex only faintly reflexed; thorax with a broad, longitudinal impunctate band at middle; scutellum entirely and densely hairy; Louisiana, Arkansas, and Texas.....*robusta* LeConte
   Color usually testaceous or rufocastaneous, often with castaneous cloudings; clypeus definitely narrowed apically; thorax without broad impunctate band.................8
8. Scutellum strongly punctate; pygidium finely and entirely scabrous in basal two-thirds or more (and rarely even to apex), apical area usually densely punctate but polished and smooth between punctures; common California and Arizona, rare New Mexico and Texas.................*pasadenae* (Casey)
   Scutellum punctate or not; pygidium usually not alutaceous or cribrose in more than basal third or fourth; eastern species, rarely west to Texas..............................9
9. Pygidium very sparsely and finely punctate the punctures of center disc hard to see, disc usually surface smooth and hairy (frequently hairs nearly entirely worn off); scutellum coarsely and usually densely and setigerously punctate (genitalia Fig. 1, *q* through *u*); Arkansas and eastern United States. *borealis* Arrow
   Pygidium minutely cribrate at least near base the punctures of center disc coarse and obvious; disc denser punctured than *borealis;* scutellum impunctate or very sparsely punctured with apical half usually smooth (genitalia Fig. 1, *y* and *z*); North Carolina and Georgia, west to Kansas and Texas. *immaculata* Oliver

KEY TO THE FEMALES

(Females of *knobelae* and *setidiosa* not included)

1. Hind tarsus much shorter than tibia, or at least definitely shorter; head with the front

coarsely, moderately densely punctured, not rugose; clypeus long and subtruncate, apex reflexed, disc coarsely transversely cribrate; pygidium entirely and cribrately punctate . 2
Hind tarsus subequal to or longer than tibia . . 3

2. Antennal club ovate and short, length of club 2–3 times as long as width through middle of leaves; elytra testaceous and thorax almost always red (very rarely black); western United States and Central America. *dimidiata* Burmeister
Antennal club long and slender, length of club 4–5 times as long as width through middle of leaves; color always testaceous with thorax a little rufous; Arizona, California, Lower California . . . . *longula* LeConte
3. Clypeus highly polished and smooth, hardly punctate or very finely punctured; front tibia bidentate with an obsolete upper tooth; pygidium very finely and sparsely punctured and polished; Georgia, Alabama, and Florida . . . . *puberula* LeConte
Clypeus always densely punctured 4
4. Body very robust; clypeal disc uneven, suddenly depressed at and on the strongly bisinuate suture, the disc very coarsely and entirely rugosely punctate; clypeus strongly narrowed in apical entirely rugosely punctate; clypeus strongly narrowed in apical half; ligula narrowed to a broad but sharp point; California and Nevada east to Texas. *hirta* LeConte
Body smaller and much less robust; clypeus and head not as above; ligula never exactly pointed at apex 5
5. Elytra at middle of lateral margin with a slight to strong, but very discernible, explanate and lobate callus, especially noticeable, when not well developed, in ventral-lateral view, and here the sudden widening of margin is distinct 6
Elytra without a lateral callus or enlargement. 7
6. Lateral swelling of elytra usually rather large and quite noticeable; sides and basal corners of pygidium very coarsely cribrate; *mentum usually definitely flat;* eastern States west to Texas . . . . *immaculata* Oliver
Lateral swelling of elytra usually narrow though obvious if looked for; *mentum* and part of ligula usually rather strongly *convex* or at least noticeably convex; Arkansas and eastern United States . . . . . . *borealis* Arrow
7. Color dark castaneous, thorax rufous, usually strongly pilose above, especially the elytra (hairs often abraded); clypeus strongly narrowed from the base; uncommon in Louisiana and Arkansas . . . . *robusta* LeConte
Color testaceous to rufotestaceous, with castaneous cloudings; glabrous above; clypeus narrowed from about the middle; common in California, Lower California, and Arizona, east to Texas . . . . *pasadenae* (Casey)

Cyclocephala knobelae (Brown)

Ochrosidia knobelae Brown, p. 23; Sanderson, 1940, p. 380.

I have not seen this species, and the notes are taken from Sanderson. Described from Hope, Ark., and not taken since to my knowledge. The small size (9 mm) and the singly toothed (apical tooth only present) front male tibia should readily separate the species. The genitalia as pictured by Sanderson are allied to those of *hirta*, but the paramere base is narrower here and the sides are evenly rounded near base.

Cyclocephala dimidiata Burmeister

Cyclocephala dimidiata Burmeister, 1847, p. 57; Sanderson, 1940, p. 379; Casey, 1915, p. 161 (*Dichromina*); Saylor, 1937, p. 70 (*Dichromina*).
Ochrosidia ocularis Casey, 1915, p. 162. (New synonymy.)
Cyclocephala elegans Horn, 1871, p. 337; Casey, 1915, p. 162 (*Dichromina*). (New synonymy.)

This common species ranges from Arkansas and through the southwestern United States, to Mexico and Central America and South America. Damages green fruits and leaves of fruit trees; roses and walnuts in California are frequently damaged or defoliated. The grass roots of lawns or golf greens are commonly attacked. Closely related to *longula* in the male genitalia (a little longer parameres there), this species differs mainly in the constant coloration as well as the ovate antennal club, the same being very well developed in *longula*.

Cyclocephala puberula LeConte

Cyclocephala puberula LeConte, 1863, p. 80; Casey, 1915, p. 147 (*Ochrosidia*).

I have seen specimens of this relatively uncommon species from Georgia, Alabama, and Florida. The male genitalia are near those of *hirta*, but externally the species are very different.

Cyclocephala setidiosa LeConte

Cyclocephala setidiosa LeConte, 1856, p. 79; Casey, 1915, p. 158 (*Ochrosidia*).

An uncommon species from Mississippi, Alabama, and Georgia. The male genitalia are exactly the same as *longula*, but externally the species are quite different: in *longula* the mid-apical thoracic margin is definitely but ob-

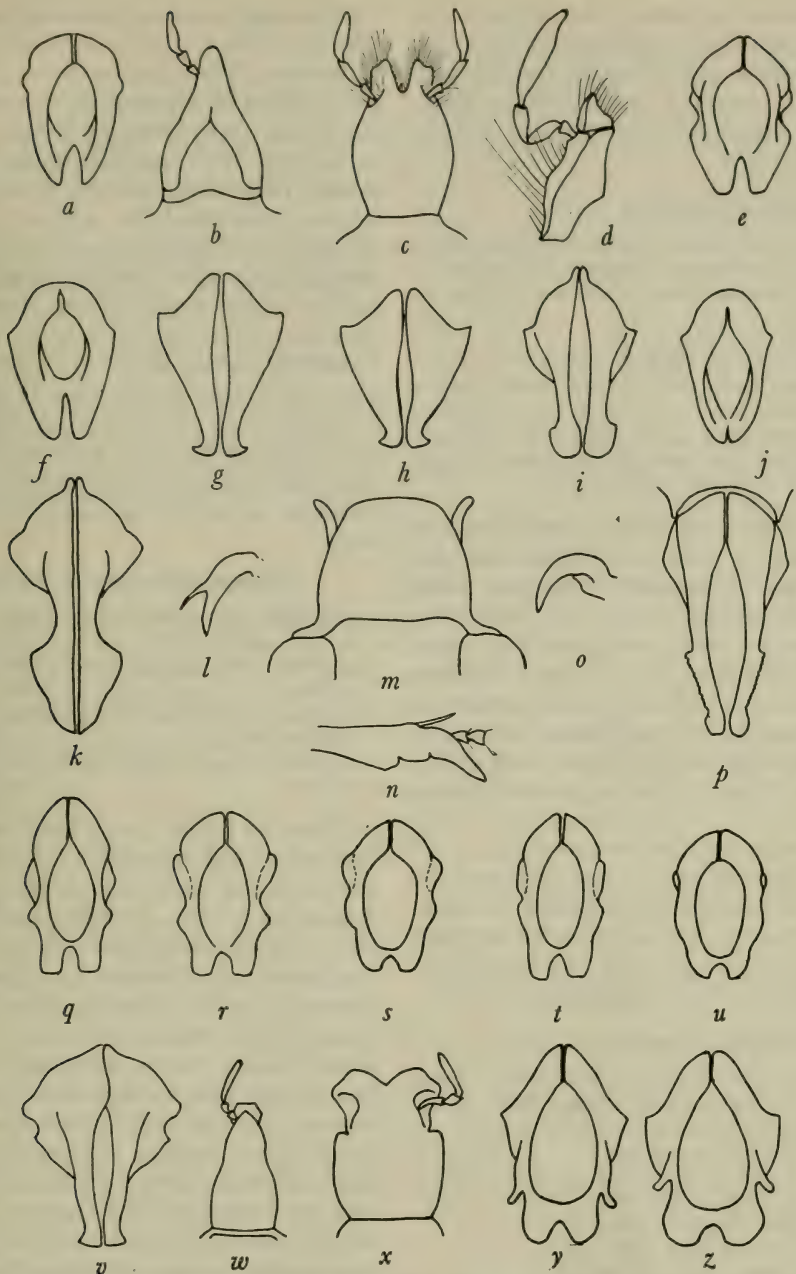


Fig. 1.—*a*, Male genitalia of *Cyclocephala hirta; b*, ligula of *Coscinocephalus cribrifons; c*, ligula of *Ancognatha manca; d*, maxilla of *Coscinocephalus cribrifons; e*, male genitalia of *Cyclocephala pasadenae; f*, male genitalia of *C. robusta; g*, male genitalia of *C. longula; h*, male genitalia of *C. dimidiata; i*, male genitalia of *Ancognatha manca; j*, male genitalia of *Cyclocephala puberula; k*, male genitalia of *Dyscinetus morator; l*, front male claw of *Cyclocephala dimidiata; m*, head and clypeus of male *C. longula; n*, front tibia of male *C. setidiosa; o*, front claw of male *C. longula; p*, male genitalia of *Coscinocephalus cribrifons; q*, male genitalia of *Cyclocephala borealis* (typical form, from Pennsylvania); *r*, same, from Malcolm, Nebr.; *s*, same, from Egypt, Ga.; *t*, same from Egypt, Ga.; *u*, same, from Orlando, Fla.; *v*, male genitalia of *Dyscinetus picipes; w*, male ligula of *Cyclocephala hirta; x*, male lingula of *Ancognatha manca; y*, male genitalia of *Cyclocephala immaculata* (commonest form, from Georgia), *z*, same, from Texas.

tusely prolonged anteriorly, the clypeal disc is coarsely and entirely punctate, and the fore tibia is tridentate; in *setidiosa* the fore thoracic margin is not prolonged, the clypeal disc is impunctate in apical half, and the fore tibia is different (Fig. 1, *n*).

Cyclocephala hirta LeConte

Cyclocephala hirta LeConte, 1861, p. 346; Casey, 1915, p. 132 (*Spilosota*); Saylor, 1937, p. 69.
Spilosota palidissima Casey, 1815, p. 133; Saylor, 1937, p. 69.
S. magister Casey, 1915, p. 132.
S. inconspicua Casey, 1915, p. 133.
S. nubeculina Casey, 1915, p. 131. (New synonymy.)
S. lurida Bland, 1863, p. 354. (New Synonymy.)
Subspecies: *Cyc.* (*Spilosota*) *hirta pilosicollis* Saylor, 1936, p. 2; Saylor, 1937, p. 69.

The mentum is very strongly acuminate and pointed, with the maxilla emerging from the sides of the point. The maxilla have only three minute, hardly discernible teeth. A widely distributed species, and I have seen very large series from California, Utah, Nevada, Arizona Texas, and Lower California. The species is usually testaceous, with castaneous and irregular cloudings on thorax and elytra; most of the Arizona and Texas forms are entirely testaceous.

The subspecies *pilosicollis* Saylor ranges from Sacramento and Davis in central California to Burbank and Pasadena in California. It is distinguished from the typical form by the light testaceous color and the very long hairs over the front, thorax, elytra, and pygidium.

Cyclocephala longula LeConte

Cyclocephala longula LeConte, 1863, p. 79; Casey, 1915, p. 158 (*Ochrosidia*); Saylor, 1937, p. 69.
Cyclocephala californica Arrow, 1937, p. 9 (n. n. for *rustica*). (New synonymy.)
Ochrosidia abrupta Casey, 1915, p. 152; Saylor, 1937, p. 69. (New synonymy.)
O. phasma Casey, 1815, p. 153.
O. obesula Casey, 1915, p. 156.
O. oblongula Casey, 1915, p. 156.
O. rustica Casey, 1915, p. 157 (not Ol. 1789).
O. reflexa Casey, 1915, p. 153.
O. marcida Casey, 1915, p. 155. (New synonymy.)
O. rugulifrons Casey, 1915, p. 154. (New synonymy.)
O. prona Casey, 1915, p. 157. (New synonymy.)
O. ambiens Casey, 1915, p. 155. (New synonymy.)
O. modulata Casey, 1915, p. 154. (New synonymy.)
Cyclocephala abrupta Casey, Ritcher, 1944, p. 17, (larva).

This widely distributed species, known from Oregon, Arizona, Lower California, Utah, and all parts of California is extremely common in the last state during most of the summer nights and is commonly attracted to light. The color varies very little, and the elongate form and sharply reflexed clypeus will readily place the species. I expressed the opinion in 1937 that *abrupta* Casey would probably prove to be the same as the earlier-described *longula* LeConte and the recent study of long series from the Ross and Michelbacher trip to all parts of Lower California has proved the two synonymous. Very close to *dimidiata* in male genital and most other characters but especially different in the much longer antennal club of both sexes, and the forked front claw in the male of *dimidiata* being here at most finely cleft, or entire.

Cyclocephala robusta LeConte

Cyclocephala robusta LeConte, 1863, p. 79; Sanderson, 1940, p. 380.
C. nigricollis Burmeister, 1847, p. 54; Horn, 1871, p. 336.
Ochrosidia nigricollis Burmeister; Buchanan, 1927, p. 167.
O. subvittata Brown, 1930, p. 5; Sanderson, 1940, p. 380.

Sanderson (1940) has pointed out his belief that *robusta* and *nigrocollis* were not the same species, basing his opinion on the examination of the female type of Burmeister's. Horn in 1871 examined the types of both species and considered them identical and Buchanan did likewise in 1927, following Horn. Sanderson separates the two on the shape of the front thoracic angles, length and shape of hind spurs, distance apart of the front tibial teeth, *and* the presence or absence of a dilation at middle of lateral elytral margin; considering these characters, all are *highly variable* in this large genus, with the exception of the last one, namely the swollen margin of the elytra, and so far as I have experienced this varies but little; therefore the two species may be different, but it will be necessary to secure series and males to be really sure. The species is known from Louisiana, Arkansas, and Texas. A single male recently collected on cotton at Lavaca, Tex., is this species, although appearing quite different in color: entirely testaceorufous above with a broad castaneous stripe adjoining the elytral suture, and also coloring the apical eighth of

the elytra, and with a small dark posthumeral umbo spot.

Cyclocephala pasadenae (Casey)

Ochrosidia pasadenae Casey, 1915, p. 148; Saylor, 1937, p. 70 (*Cyclocephala*).
O. arizonica Casey, 1915, p. 149 (New synonymy.)
O. melina Casey, 1915, p. 149. (New synonymy.)
O. pusilla Casey, 1915, p. 150. (New synonymy.)
O. facilis Casey, 1915, p. 150. (New synonymy.)
O. validiceps Casey, 1915, p. 148. (New synonymy.)
O. ovatula Casey, 1915, p. 151. (New synonymy.)

I have examined great series of this common species, which ranges from Lower Calfornia, throughout California, and west through Arizona, New Mexico, and Texas. It is not very variable.

Cyclocephala borealis Arrow

Cyclocephala borealis Arrow, 1937, p. 172 (n. n. for *villosa* Burmeister).
Cyclocephala villosa Burmeister, 1847, p. 54 (non Blanchard, 1846); LeConte, 1863, p. 79; Saylor, 1937, p. 69; Sanderson, 1940, p. 382.
Ochrosidia villosa Burmeister, Casey, 1915, p. 147; Hayes, 1918, p. 135 (biology); Ritcher, 1944, p. 18 (larva).
O. parallela Casey, 1915, p. 144. (New synonymy.)

Distributed from Arkansas and east, rather common along the eastern coast. The pygidium and apical areas of the elytra are usually covered with long and erect hair, but this is very frequently entirely abraded. The male genitalia appear to be more variable in this species than in any other United States species; the Nebraska specimen figured (Fig. 1, *r*) has the male genitalia somewhat similar to those of *immaculata*, but the small lateral toothlike angulation is not sinuate apically at its base, as is the lateral tooth in *immaculata*. The male genitalia of *parallela* specimens from Georgia and Florida look superficially a little different owing to the more rounded lateral process of the parameres, but the slight variations as shown in the two figures of the Georgia specimens (Fig. 1 *s* and *t*), plus the figure of the Florida specimens (Fig. 1, *u*) show how the small notch between the small submedian tooth (or toothlike dilation) and the more basal dilation is filled in, and how the resulting rounder and less-incised genitalia is that of an entirely different-appearing species.

Cyclocephala immaculata Olivier

Cyclocephala immaculata Olivier, 1789, p. 29; Bates, 1888, p. 334; Sanderson, 1940, p. 384; Saylor, 1937, p. 70.
C. frontalis Sturm, 1843, p. 116.
Ochrosidia rufifrons Casey, 1915, p. 145.
O. tenuicutis Casey, 1915, p. 146. (New synonymy.)
O. pagana Casey, 1915, p. 148. (New synonymy.)
O. protenta Casey, 1915, p. 144. (New synonymy.)

A common species in the eastern United States; I have seen specimens from Missouri, Texas, Oklahoma, Kansas, and Arkansas, and from North Carolina, South Carolina, and Georgia in the southeast. Recorded in literature from New Mexico and Guadeloupe, but possibly these may refer to other species. The larvae were described by Forbes in 1894 and Ritcher in 1944. I have seen a male specimen from Thomasville, Ga., that is entirely black above, with the legs and abdomen testaceorufous to castaneous; the male genitalia are exactly similar with the typical form. As the figures indicate (Fig. 1, *y* and *z*), the small lateral tooth of the male genitalia varies in position and is more apical in position in the more eastern specimens, but this is an individual variation and all intermediates occur so that it is not of even varietal import.

Aspidolea texana Höhne

Aspidolea texana Höhne, 1912, p. 84.

This is very probably based on a wrongly-labeled specimen from Texas, as I do not believe that the genus occurs here: if it should, the key characters to the genus, plus the extremely broad and very flat ligula and mentum (which is wider at apex than at base) should readily place the species. All other 13 described species of this genus occur in Central America and South America. Male front claws are enlarged and the maxilla is unarmed. *A. texana* was described from San Antonio, Tex., and was a unique female 15 mm long and reddish brown, with the forehead and vertex black.

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ENTOMOLOGY.—Scheloribates chauhani, *a new species of oribatid mite from India* (*Acarina: Ceratozetidae*).[1]

Edward W. Baker, United States Department of Agriculture. (Communicated by C. F. W. Muesebeck.)

The discovery that *Zetes emarginatus* (Banks),[2] family Galumnidae, is an intermediate host of the sheep tapeworm, *Moniezia expansa* (Rudolphi), has aroused much interest in the oribatid mites during the past few years. This species, which lives on grass in sheep pastures, was found to be infected with the cysticercoidal stage of the parasite.

B. S. Chauhan, of the Zoological Survey of India, while conducting studies on the sheep tapeworm, has collected oribatid mites from grass. However, these mites belong to the genus *Scheloribates*, family Ceratozetidae, and appear to represent a new species.

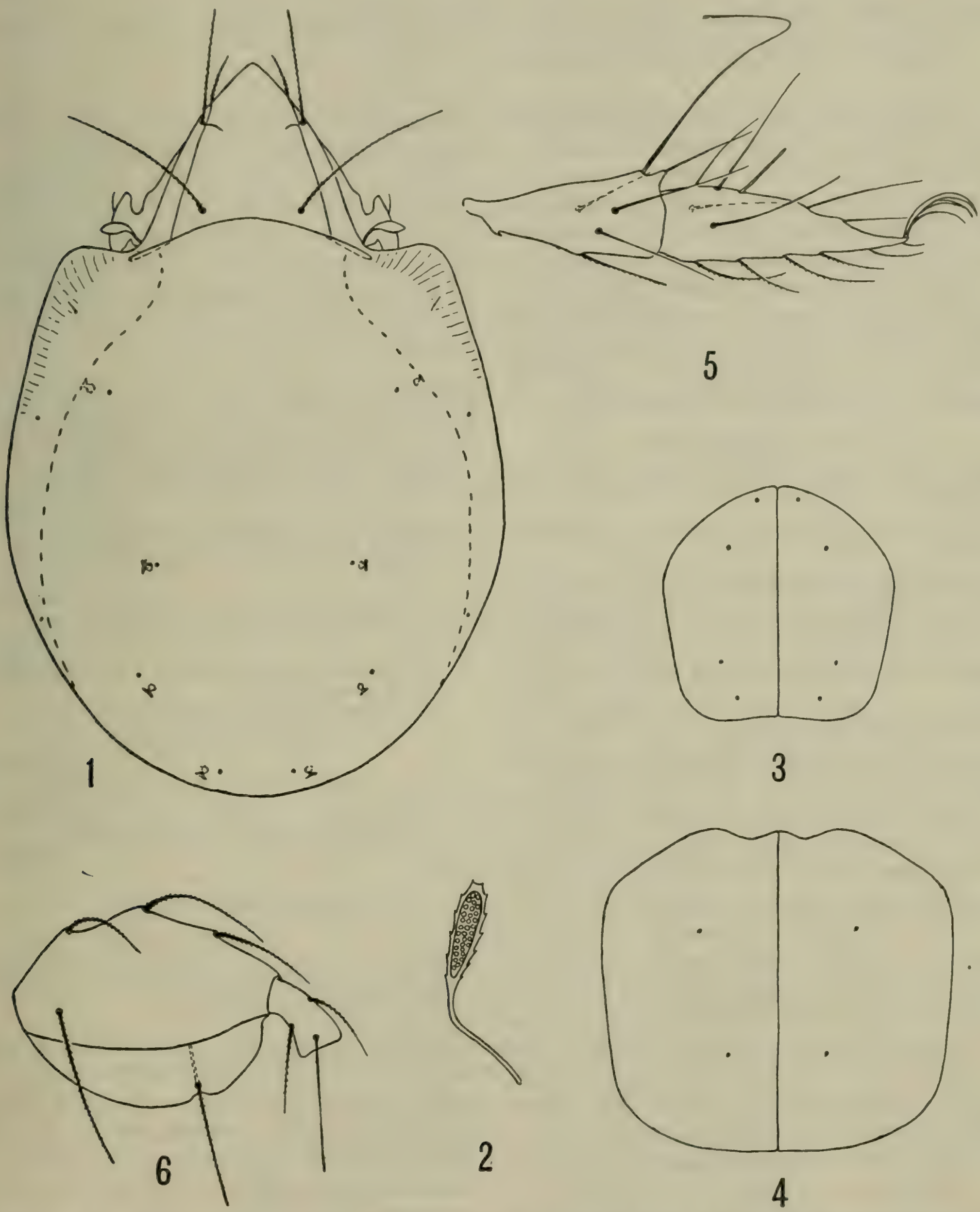
Scheloribates chauhani, n. sp.

Female.—Abdomen round-oval; all cephalothoracic bristles barbed, the interlamellar setae inserted nearer to edge of notogaster than to lamellae and longer than others; lamellae tapering distally, not undulate externally, and sides of cephalothorax not or barely visible from above; translamellar lines short; lamellorostral ridge well developed and embracing base of rostral bristle; each pseudostigma with rim usually slightly surpassing edge of pteromorpha, pseudostigmatic organs with head equal to length of pedicel, "oil globules" present, barbs small but distinct. Abdomen with anterior edge of notogaster mildly bowed, its sides merging into pteromorphae; dorsum of abdomen equally arched when viewed from side; pteromorphae with a bristle on anterodorsal area, and with radial combings or fine corrugations on shoulders; dorsal setal pits as figured (body setae apparently knocked off); anal plates wider than long, sides almost parallel, posterior cover bristles closer to inner edge than are anterior bristles, and bristles subequally spaced from anterior and posterior edges; genital plates slightly wider than long, broadly rounded anteriorly, and only slightly concave posteriorly, setae arranged as figured, lateral margins longer than anterior margins. Tarsus I with ventral ciliate setae, dorsal simple setae, and a short rodlike dorsal setae as

[1] Received October 9, 1945.
[2] H. W. Stunkard, Science 86: 312. 1937; W. H. Krull, Proc. Helminth. Soc. Washington 6 (1): 10, 11. 1939.

figured; femur II as figured, all setae barbed, the posterior dorsal seta barely reaching past base of median seta; the dorsal posterior angle of femur rather abrupt; tectopodium III notched but not strongly so; sides of tectopodia II mildly converging toward rostrum. Length of body 533μ, width 393μ.

Scheloribater chauhani differs from *S. indica* Oudemans, which is from Ceylon, in having pectinate cephalothoracic setae and in having an elongate pseudostigmatic organ that is distinctly barbed. It differs from *S. muiri* Jacot, a Hawaiian species, in having all cephalothoracic setae pectinate, in having a rounded



Figs. 1–6.—*Scheloribates chauhani*, adult female: 1, Dorsal view of body; 2, pseudostigmatic organ, 3, genital plates; 4, anal plates, 5, tarsus and tibia I; 6, femur II.

rather than a pointed genital opening, in having the lateral margins of the genital plate longer than the anterior margins, in the setal arrangement of the anal plates, in that the posterior dorsal setae of femur II does not reach the base of the anterior seta, and in femur II having an abrupt rather than a gentle posterior dorsal angle.

The type, U.S.N.M. no. 1515, and 10 paratypes, which were sent in by B. S. Chauhan and named for him, were collected from grass, Izatnagar (Bareilly), U. P., India.

ZOOLOGY.—*The West Pacific species of the molluscan genus* Aforia.[1] PAUL BARTSCH, U. S. National Museum.

In the preparation of a monograph on the East Pacific mollusks, recent and fossil, of the family Turridae, it became necessary to examine the congeneric elements dwelling in the western Bering Sea and the cold inshore waters of the Asiatic side of the Pacific. In the case of the genus *Aforia* I find that a much greater degree of specialization and differentiation has taken place in the Asiatic fauna than in American waters, as demonstrated by the present little monograph.

Genus **Aforia** Dall

1889. *Aforia*, Dall, Bull. Mus. Comp. Zool. **18**: 99.
1908. *Aforia*, Dall, Bull. Mus. Comp. Zool. **43**: 257.

Shell large, turreted, covered by a thin periostracum when perfect. Last whorl longer than the spire preceding it. Nucleus slender, multispiral, with the surface worn in all our specimens. A strong median keel is present on the middle of the postnuclear whorls. The deep anal notch falls halfway between the keel and the summit of the turns. The surface is marked by spiral lirations and fine incremental lines. Part of the adult shells bear a second fold, which begins on the middle of the last turn and gradually develops into a clawlike channel posterior to the anterior termination of the base. This is probably a sexual character. Columella long, attenuated, concave on the left side. Aperture large, elongate pear-shaped with the anterior half narrowed into a moderately wide channel; outer lip thin; inner lip sigmoid, forming a thin callus on the columella and parietal wall. Operculum narrow, thin, corneous, clawlike with lateral subapical nucleus marked by low, concentric threads. Radula with rather large rachidian and Y-shaped marginals.

On the Asiatic side we find *Aforia insignis* (Jeffreys) south of St. Lawrence Island; from there the genus extends southward along the coast of Sakhalin Island in the Okhotsk Sea to the outside of Hokkaido and Honshu, and one species has been taken off the coast of Chosen.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 17, 1945.

KEY TO THE WEST PACIFIC SPECIES OF OOFRIA

Spiral cords on columella more than 50. .*japonica*
Spiral cords on columella less than 35.
  Spiral cords on columella more than 30. *diomedea*
  Spiral cords on columella less than 20.
    Spiral cords of penultimate whorl anterior to keel 18.
      Spiral cords on keel very strong. *hondoana*
      Spiral cords on keel not very strong. *insignis*
    Spiral cords of penultimate whorl anterior to keel, less than 16.
      Adult shell large, more than 60 mm.
        Base with 4 strong spiral cords. *okhotsensis*
        Base with 9 weak spiral cords. *sakhalinensis*
      Adult shell small, less than 46 mm. *chosensis*

Aforia japonica (Dall)

Figs. 5, 6

1925. *Turricula japonica* Dall, Proc. U. S. Nat. Mus. **66**: 29, pl. 26, fig. 11.

Shell of medium size, covered with a thin pale gray periostracum. The whorls bear a strong, slightly upturned, median keel, which is frequently split. Posterior to the keel the shell bears mere indications of microscopic spiral striations. Anterior to the keel, on all but the last whorl, there is no indication of spiral sculpture. On the last whorl, however, anterior

to the keel, numerous, feebly incised, spiral lines are present, of which about 24 appear on the base and more than 50 on the columella. On the anterior fourth of the columella they disappear altogether. In addition to this, the base and columella are marked by strong incremental lines, which give to the surface a somewhat clothlike texture. Aperture extremely elongate-pyriform. Outer lip with a deeply incised sinus, having its greatest depth a little anterior to the middle between the keel and the summit. Anterior to the sinus the outer lip is protracted. Inner lip very elongate-sigmoid. The columella and parietal wall rendered smooth by resorption at the inner lip. The left outline of the base and columella is concavely slightly sigmoid.

The type, U.S.N.M. no. 205041, was dredged by the *Albatross* at station 5088 off Joka Sima Light in Sagami Bay, Honshu, Japan, in 369 fathoms; bottom temperature, 41.8°F., on green mud bottom. It has 8 whorls and measures: Height, 53 mm; greater diameter, 18.1 mm; length of last whorl, 34.3 mm.

U.S.N.M. no. 205038 contains a young specimen dredged by the *Albatross* at station 5093 off Joka Sima Light in 302 fathoms; bottom temperature, 43.9°F., on black sand and broken shell bottom.

This species can readily be distinguished from all the others by its extremely feeble sculpture of the base and columella.

Aforia diomedea, n. sp.

Figs. 11, 12

Shell very large, rather narrow, elongate-turreted, covered with a pale gray, putty-colored periostracum. The whorls are encircled by a strong, up turned median keel. Posterior to the keel are 2 spiral threads and more microscopic spiral lines. The keel itself bears closely spaced spiral threads. Anterior to the keel 7 strong, rounded spiral cords are present between the summit of the last turn and the keel. These are a little broader than the spaces that separate them. Anterior to this the rest of the base and columella are marked by 40 incised grooves which separate rather flattened spaces of about the same width or a little wider than the grooves. Some of these bear one to three fine incised lines. In addition to this the entire base and columella are marked by incremental lines. Aperture elongate pear-shaped. Outer lip with a deep sinus a little anterior to the middle between the summit and keel, protracted anteriorly to the keel. The inner lip is decidedly sinuous and by resorption causes the columella and parietal wall to appear as a glazed surface. The left side of the base and columella is decidedly concave.

The type, U.S.N.M. no. 205039, was dredged by the *Albatross* at station 5044 off Yerimo Zaki, southeast Hokkaido, in 309 fathoms; bottom temperature, 32.1°F., on gray sand, coral and sand bottom. It has 8.5 whorls remaining and measures: Height, 92 mm; greater diameter, 30.6 mm; length of last whorl, 51.1 mm.

U.S.N.M. no. 205036 contains 2 specimens dredged by the *Albatross* at station 5050 off Kinka San Light east of Sakhalin Island, in 266 fathoms; bottom temperature, 37.9°F., on dark gray sand and broken shell and Foraminifera bottom.

U.S.N.M. no. 205040 contains 1 specimen dredged by the *Albatross* at station 5045 off Yerimo Zaki southeast Hokkaido, in 359 fathoms; bottom temperature, 38°F., on brown mud and fine broken shell and coral sand bottom.

U.S.N.M. no. 205037 contains 1 specimen dredged by the *Albatross* at station 5051 off Kinka San Light, east of Sakhalin Island, in 399 fathoms; bottom temperature, 38.1°F., on dark gray sand and broken shell and Foraminifera bottom.

U.S.N.M. no. 342737 contains 1 specimen from the Hirasé collection (1402) taken at Rikuzen northeast of Honshu, Japan.

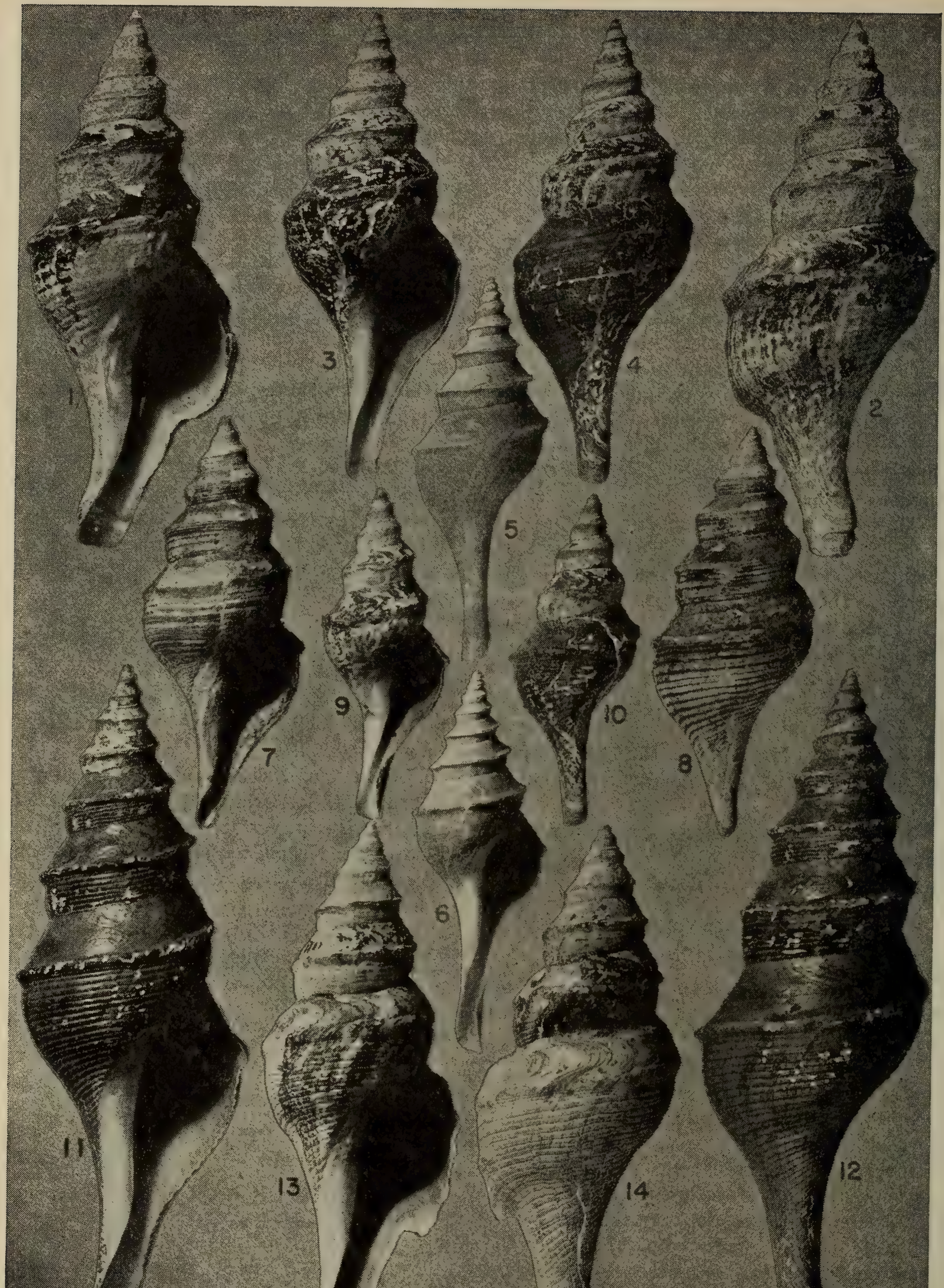
This species can readily be distinguished from all the others by its large size, gray coloration, and perfection of sculpture.

Aforia hondoana (Dall)

Figs. 7, 8

1925. *Turricula* (*Surcula*) *hondoana* Dall, Proc. U. S. Nat. Mus. **66**: 29–30, pl. 31, fig. 6.

Shell of medium size, turreted, covered by a gray periostracum. Interior of the aperture yellowish white. Nuclear whorls decollated. The postnuclear whorls bear a strong median keel, anterior to which the whorls are slopingly shouldered and marked by obsolete microscopic spiral striations. The keel bears 3 rather strong spiral threads. Anterior to the keel the whorls are marked by 6 very strong spiral



FIGS. 1–14.—West Pacific species of the genus *Aforia*. 1, 2, *A. okhotskensis*, n. sp.; 3, 4, *A. sakhalinensis*, n. sp.; 5, 6, *A. japonica* (Dall); 7, 8, *A. hondoana* (Dall); 9, 10, *A. chosenensis*, n. sp.; 11, 12, *A. diomedea*, n. sp.; 13, 14, *A. insignis* (Jeffreys). All about $\times 1\frac{1}{7}$.

cords which are separated by deep grooves not quite as wide as the cords. The base is well rounded and bears 7 very strong spiral cords also separated by deeply incised grooves. The columella is moderately long and bears 18 spiral cords which become progressively finer anteriorly. Aperture pear-shaped. The posterior sinus falls on the shoulder and is deep, broad, and rounded at base. Anterior to the keel the outer lip is protracted and rendered sinuous by the external sculpture. The inner lip is covered with a thick callus which somewhat covers the parietal wall.

The type, U.S.N.M. no. 111052, was dredged by the *Albatross* at station 5087 in Sagami Bay off Hondo, Japan, in 614 fathoms on mud bottom; bottom temperature 37.5°F. It has 6.5 whorls remaining and measures: Height, 56.2 mm; greater diameter, 21.5 mm; length of last whorl, 31.4 mm.

This species in general shape and sculpture most nearly resembles *A. insignis* from which its much smaller size and much stronger spiral sculpture will readily distinguish it.

Aforia insignis (Jeffreys)

Figs. 13, 14

1883. *Pleurotoma insignis* Jeffreys, Ann. Mag. Nat. Hist. 1883: 119–120.

Shell large, turreted. The patches of periostracum remaining show this to have been reddish brown. The interior of the aperture is ochre yellow. Nuclear whorls decollated. The postnuclear whorls are marked by a strong median keel which bears 5 fine spiral threads. Anterior to this keel the whorls are well rounded and marked by decidedly sinuous incremental lines which show that the posterior sinus is deep and broad. Anterior to the keel are 2 slender spiral threads equaling those on the keel in strength. This area is impressed and forms a slight groove. Anterior to this the whorls are marked by 7 spiral cords which are of somewhat varying strength and which are separated by deeply impressed narrow grooves. The base is well rounded and also bears 7 spiral cords equaling those of the spire in strength. Some of these are marked medially by a fine incised spiral line. The columella is long and bears 18 spiral cords which are of subequal strength. The axial sculpture consists of incremental lines only which are rendered decidedly sigmoid due to the deep posterior sinus. In the specimen described, the last portion of the last whorl embracing the anterior 4 spiral cords, becomes somewhat folded and projects at the peristome as a slight claw. Aperture pear-shaped. Outer lip with a deep broad sinus on the shoulder, protracted anterior to the keel, and rendered somewhat sinuous by the external sculpture. The inner lip is covered with a thick callus, which extends over the parietal wall.

The specimen described and figured, U.S. N.M. no. 190815, comes from the Jeffreys collection and is one of 10 collected on the Vega Expedition in the Icy Sea of Siberia. It was used as the basis for Jeffreys' description and may therefore be considered the type of the species. It has 7.5 whorls remaining and measures: Height, 72.4 mm; greater diameter, 27.8 mm; length of last whorl, 41.5 mm.

In the elements of sculpture it most nearly resembles *A. hondoana*, from which, however, its larger size and less strong spiral sculpture will readily distinguish it.

Aforia okhotskensis, n. sp.

Figs. 1, 2

Shell large, turreted, interior pale buff, exterior covered by a thin gray periostracum, which is eroded in most part. A strong median spiral keel almost midway between summit and suture is present. Posterior to this keel the surface is marked by incremental lines and spiral lirations about as strong as the incremental lines. The anal sinus falls a little nearer the keel than the summit. Anterior to the keel the last whorl is rough and marked by deeply incised grooves which leave broad, rather rough, flattened spaces between them. Of these grooves, 8 are present between the keel and the insertion of the columella, the one bordering the keel being the deepest. On some of the spaces between these deep grooves there are indications of a median, secondary, less strong groove, while the keel itself is marked by finer spiral threads. The rather protracted columella is marked by 8 deeply impressed, spiral grooves which separate spaces about as wide as those on the base. In the anterior portion of the columella they seem to disappear. In addition to this, the columella and base are marked by strong incremental lines. In the type there is a secondary spiral ridge about as far anterior to the keel as that is from the summit, which corresponds to a secondary notch in the outer lip.

Aperture very elongate pear-shaped with the anal sinus deeply incised. Anterior to this the outer lip is protracted; the inner lip is decidedly sigmoid, while the left outline of the base and columella is decidedly concave.

The type, U.S.N.M. no. 205042, was dredged by the *Albatross* at station 5020 off the east coast of Sakhalin Island near Cape Patience, Okhotsk Sea, in 73 fathoms; bottom temperature, 30.9°F., on green mud, sand, and pebbly bottom. It has 7.5 whorls remaining and measures: Height, 73.8 mm; greater diameter, 28.5 mm; length of last whorl, 43 mm.

U.S.N.M. no. 205044 contains a young specimen dredged by the *Albatross* at station 5005 in Aniwa Bay on the east side of Sakhalin Island, Okhotsk Sea, in 42 fathoms; bottom temperature, 42°F., on green mud and fine gray sand bottom.

This species most nearly resembles *A. insignis* from which it can be distinguished by its much coarser spiral sculpture.

Aforia sakhalinensis, n. sp.

Figs. 3, 4

Shell turreted, covered with a thin pale buff periostracum. Interior of aperture with an ochre flush. The whorls bear a strong median keel, anterior to which they are covered by fine microscopic hair lines and strongly sigmoid incremental lines of about the same strength, which follow the outline of the anal sinus. The anterior termination of the keel consists of a deeply impressed groove. The keel itself is crossed by fine spiral lines. Anterior to this groove the whorls are crossed by 14 incised grooves, which vary from mere lines to rather broad flat channels. The grooves and flattened spaces between them are crossed by rather strong incremental lines, which in the broad grooves assume the strength of hair lines. The columella is also marked by spiral grooves, of which 15 are present. The spaces enclosed by these are more rounded than those on the base, the axial incremental lines being of the same strength. On the extreme tip of the columella the spiral sculpture gradually fades out. Aperture elongate-pyriform; outer lip with a deep sinus whose greatest depth is a little nearer the keel than the summit of the whorls. The outer lip is protracted anteriorly to the keel. The inner lip is decidedly sinuous and covers the columella and parietal wall as a smooth resorption area. The left outline of the base and columella is decidedly concave.

The type, U.S.N.M. no. 573613, was dredged by the *Albatross* at station 5051 off Kinka San Light east of Sakhalin Island in 399 fathoms; bottom temperature, 38.1°F., on dark gray sand and broken shell and Foraminifera bottom. It has 7.5 whorls remaining and measures: Height, 63.8 mm; greater diameter, 24 mm; length of last whorl, 36.3 mm.

U.S.N.M. no. 573614 contains a young specimen dredged by the *Albatross* at station 5050 off Kinka San Light east of Sakhalin Island, in 266 fathoms; bottom temperature, 37.9°F., on dark gray sand and broken shell and Foraminifera bottom.

This species most nearly resembles *A. chosenensis* but can readily be distinguished from that by its less strong basal sculpture and larger size.

Aforia chosenensis, n. sp.

Figs. 9, 10

Shell small, turreted, the exterior covered with a grayish buff, thin periostracum. Interior of the aperture pale buff. The whorls bear a strong, decidedly elevated, median keel, posterior to which the slightly concave surface is marked by decidedly sigmoid lines of growth and microscopic spiral striations. Anterior to the keel the shell and the base and columella are marked by deeply incised, rather broad grooves which are a little more distantly spaced immediately below the keel than on the rest of the shell. These grooves enclose almost flattened areas which are a little narrower near the keel than on the rest of the surface. Eleven of these are present between the keel and the insertion of the columella, and 12 more on the columella where they gradually grow weaker anteriorly. In addition to this, the entire surface is marked by fine microscopic spiral striations and lines of growth. The latter appear almost as hair lines in the deep grooves. The keel itself is marked by fine spiral threads. The base of the last whorl and columella are decidedly concave on the left side. Aperture rather narrow, very elongate pear-shaped with a deep sinus a little anterior to the middle above the shoulder. The outer lip is protracted anterior to the keel and rendered somewhat sinuous by the external sculpture. The inner

lip is elongate-sigmoid. The columella is excavated into a smooth surface which also extends over the parietal wall.

The type, U.S.N.M. 205043, was collected by the *Albatross* at station 4860 off Cape Clonard, southeast coast of Chosen, Japan Sea, in 122 fathoms on gray mud bottom; bottom temperature 34.1°F. It has 6 whorls remaining and measures: Height, 45.5 mm; greater diameter, 18 mm; length of last whorl, 27.8 mm. U.S.N.M. no. 573615 contains another specimen from the same station.

The small size will readily distinguish this from the other Japanese members.

ZOOLOGY.—*On the oligochaete genus Syngenodrilus and its taxonomic relationships.*[1] G. E. Gates, Judson College, Rangoon, Burma. (Communicated by Waldo L. Schmitt.)

The oligochaete *Syngenodrilus lamuensis* Smith and Green, 1919, from Mkonumbi near Lamu on the coast of British East Africa, is known only from the original description of a single specimen. This "remarkable" species is of especial interest because of a peculiar combination of characteristics: septa 9/10–10/11 combined, 11/12 united either with 9/10–10/11 or 12/13; pregonadic gizzards, intestinal origin in region of xii–xiii; paired testis sacs (containing hearts and nephridia) in x–xi, numerous small seminal vesicles, one pair of larger, elongated seminal vesicles extending posteriorly within the ovisacs to xx, three pairs of prostates none of which are associated with the male genital ducts. *Syngenodrilus* was placed by its authors in the Asiatic family Moniligastridae primarily "because of the various important characteristics in which it is allied with *Desmogaster*" but probably as much because of the one-cell-layered clitellum and yolky ova supposedly characteristic of the Moniligastridae alone among Megadrili. Differences from other Moniligastridae were recognized as sufficient to require division of the family into two subfamilies, the Moniligastrinae and Syngenodrilinae, the latter containing only *Syngenodrilus*. This classification was accepted by Michaelsen[2] and Stephenson, apparently without really critical examination. The necessity for such examination was recognized several years ago and a discussion of the problem was prepared for publication. There was, however, so much uncertainty with regard to a number of structures of taxonomic importance that it seemed advisable to postpone consideration of the problem until the type material could be studied. Although a sabbatical leave has permitted study of the original material, a considerable proportion of the uncertainty can not yet be resolved except as regards moniligastrid relationships.

The author's thanks are due to Prof. R. C. Osburn and the authorities of the Ohio State University for the courtesies of the Department of Zoology during the winter of 1940–41, and also to Dr. Waldo L. Schmitt, of the United States National Museum, for the opportunity afforded of examining the type material of *Syngenodrilus*.

Syngenodrilus lamuensis Smith and Green

1919. *Syngenodrilus lamuensis* F. Smith and B. R. Green, Proc. U. S. Nat. Mus. **55**: 145–153, figs. 1–8.

1930. *Syngenodrilus lamuensis*, J. Stephenson, The Oligochaeta, p. 813 (*vide* also pp. 339, 671, 688, 696–697, 716, and 808–811).

[1] In the collections of the U. S. National Museum is the unique type of an earthworm collected near Lamu on the eastern coast of British East Africa by William Astor Chanler in 1892 and described by Frank Smith and Bessie R. Green in the Proceedings of the U. S. National Museum, vol. 55, pp. 145–153, 1919, as a new genus and new species. Its taxonomic relationships have long intrigued students of the oligochaetes and as a result the type material has been critically reexamined in recent years by two specialists. The results of their observations are set forth in two papers, this one by Dr. G. E. Gates of Judson College, Rangoon, Burma, and the one immediately following by Dr. Grace E. Pickford, of the Osborn Zoological and Bingham Oceanographic Laboratories, Yale University.—W. L. Schmitt.

Received October 24, 1945.

[2] Michaelsen (1928) placed *Syngenodrilus* in a separate family, the Syngenodrilidae, distinct from but supposedly closely related to the Moniligastridae.

Material examined.—The type material comprises a single specimen from which the right half of the anterior end to the region of segment xxiii was removed and serial sections of the right half, cut sagittally, on 10 slides.

Observations on the type specimen.—EXTERNAL CHARACTERISTICS: The prostomium appears to be protruded, but it and the first segment are softened and damaged. Because of the protrusion, recognition of a characteristic moniligastrid prolobous condition is impossible. Pigmentation and clitellar coloration as well as clitellar thickening are unrecognizable. Setae of segments xi, xii, and xiii are in part or wholly lacking. Close to approximate sites of ventral setae there is on each of segments xi–xiii a porelike marking that might be the aperture of a setal follicle but possibly is the opening of a prostate. Spermathecal apertures are minute, apparently immediately in front of 7/8 and 8/9, in region of *cd*. There is a minute, porelike marking on 12/13, about on *cd*, which may be the male pore, but a similar marking is present farther laterally on the anterior margin of xiii (nephropore or another male pore?). The female pore is a transversely placed slit on *a*, midway vetween the setal arc of xiv and 13/14.

INTERNAL ANATOMY: In the left half of the anterior portion remaining on the type is included the ventral nerve cord, all of one ovisac and most of another, two spermathecae, and (probably) two male funnels. Most of the digestive system behind 7/8 is lacking and blood vessels are broken. The gizzards and portions of the vascular system have been lost.

Behind the posteriormost prostate and about at level of 13/14 is a bit of membrane that presumably is 12/13. Coelomic cavity of xiii reduced to an ovarian chamber (?). Segment of intestinal origin not determinable. No typhlosole. Structures that look somewhat like moniligastrid enterosegmental organs are present on the intestine but may be only branches of vessels to the dorsal trunk from the intestine. "Hearts" of vi and vii connect the dorsal and ventral trunks to a longitudinal vessel that appears to be an extra-esophageal. Location of last heart not determinable.

The intact ovisac bends upward in the region of the prostate of xiii and in the upper half of the coelomic cavity bears at its anterior end a rosette-shaped, iridescent mass, presumably a male funnel. This funnel looks more like a megascolecid funnel than that of a moniligastrid worm. Sticky coagulum such as is always present in a moniligastrid testis sac around the male funnel is entirely lacking here. The anterior (?) male funnel is attached to a membrane that presumably represents the posterior wall of a testis sac. Both (?) testis sacs are open as a result of removal of median portions in halving. Testes, vasa deferentia, and seminal vesicles are unrecognizable. Strings of round bodies, presumably eggs, are in front of the anterior male funnel and are continuous, beneath and around the posterior face of the membrane bearing the funnel, with other egg strings. A small female funnel is present on the anterior face of 13/14 ventrally and a cord representing or containing the female duct passes from the posterior face of 13/14 into the parietes of xiv. Ovisacs are firm and apparently shrunken but at the posterior ends are several small, reddish to yellowish knobs or lobes. In a moniligastrid worm a similar collapsed condition of the ovisac, with but little yellowish material is evidence for a late postsexual condition. Spermathecal ampullae are shrunken and irregular, widest entally, not attached to the posterior faces of their septa as in the Moniligastridae. A short ectal portion of each spermatheca (duct) appears to be circular in cross section, with a thicker wall than the ampulla. There are no atria or diverticula recognizable. The prostates appear to be short tubular glands, shortly looped, with the loops pressed into contact, the glands bent posteriorly. The duct is probably confined almost entirely to the parietes.

The sections.—Portions of sections figured by Smith and Green are readily recognizable However, critical parts of the most important sections are lacking, and in remaining portions of these, as well as in other sections, delicate septa (or portions of septa) have been broken or lost. Accordingly any attempt at reconstruction scarcely seems feasible. A 4-day study of this portion of the material warrants only a few miscellaneous observations and suggestions.

Slight tension on delicate septa, in certain earthworms at least, is sufficient to rupture the membranes so that they are unrecognizable in dissections even when made with considerable care. It is quite possible then, even if if there had been no damage or loss during

sectioning, that strains incident to halving the type and washing dirt out from the gut might have been sufficient to disrupt if not destroy delicate membranes including some of the most important septa. Delicate septa might also have been ruptured in a process of sudden killing. In the moniligastrid genus *Drawida*, septal herniations permit one or both testis sacs to have an apparent location behind the ovarian segment, occasionally with a longitudinal deformation of a testis sac. Whether a similar sort of herniation is responsible for some of the peculiar appearances in sections of *S. lamuensis*, including that of seminal vesicles within the ovisacs, can not be determined from the material available. In any case, location of most of the right ovisac as well as one gizzard and part of another in the left half of the type, shows that some organs at least are distorted and not in a normally symmetrical condition. Just how extensive the distortion is can not be determined until normal specimens are available for comparison.

In view of admitted possibilities of "imperfectly developed" septa, of damage to sections, and the obvious presence of "evidence of more septa among the organs" it is difficult to imagine the reasons for an assumption of septal fusions by Smith and Green, and especially of the extensive type mentioned above. Presence of hearts and nephridia in x and xi would have prevented complete fusion, even in case of apposition of peripheral portions of certain septa. For a peripheral apposition of septa, as for instance in *Drawida* or *Hoplochaetella*, no evidence was recognized in the sections.

Determination of segmental location of the posterior hearts appears to be impossible. In some sections at least hearts appear to be present in xi and xii but lacking in x (as in certain species of *Pheretima*).

Intrasegmental location of testes and relationship of the male gonads to the anterior walls of the testis sacs, according to Smith and Green and so far as is determinable from the sections, appear to be of the sort normal to most Microdrili and Megadrili[3] and certainly are not of the moniligastrid type. (Note attachment of testes to anterior walls of testis sacs some distance in front of the male funnels and above the floors of the sacs, in fig. 3, Smith and Green, 1919, p. 149.) The position of the posterior male funnel in the sections is most peculiar. The ental-most portion of the associated male duct is dorsal to the funnel and runs posteriorly. The male funnel is horizontally elongated and faces ventrally with the back (closed face) of the funnel and duct attached dorsally. In most Megadrili the back of the funnel is directed posteriorly, while in the Moniligastridae the back is directed ventrally. In certain sections the posterior male funnel appears to be in xii. A definite statement as to paired or unpaired characterization of the testis sacs appears to be impossible though appearances seem to indicate that sacs are unpaired, i.e., there are only two sacs, one belonging to x and one to xi. Attention is also directed to the fact that in some species of *Pheretima* gonad septa may be herniated in such a way that testis sacs at first appear to be in xi and xii rather than x and xi. Essential portions of sacs of *S. lamuensis*, those containing male funnels and testes (or perhaps whole sacs?), are certainly subesophageal. In view of the condition of the sections little of value can be said regarding the segmental location of the testis sacs, except that no reason for questioning the location given by Smith and Green was recognized. If the posterior testes belong to xii (extremely improbable) as suggested by Stephenson, it would seem to be necessary to refer the anterior gonads to xi. The numerous small seminal vesicles probably are nothing more than aggregations of spermatozoa between folds of the male funnel. Seminal vesicles, if present, are of the posteriorly elongated, microdrilid type[4] as figured by Stephenson, 1930, pp. 728 and 741), rather than the vertically elongated megadrilid type (Stephenson, 1930, p. 329).

Remarks on the relationships of Syngenodrilus.—Comparison of *Syngenodrilus* with the Moniligastridae shows a number of similarities, but nearly all these are shared with other families or even larger groups: lumbricine setae (Eudrilidae, Lumbricidae, Ocnerodrilidae, Alluroidi-

[3] The terms Microdrili and Megadrili are used in this article in a loose sense, merely to refer collectively to the families Aeolosomatidiae to Haplotaxidae or Alluroididae and Moniligastridae to Lumbricidae respectively. (*Vide* Stephenson, 1930, p. 721.)

[4] Not to be confused with a secondary type of posterior elongation in certain megascolecid species.

dae, Haplotaxidae), meganephric excretory system (Eudrilidae, Lumbricidae, Ocnerodrilidae, Glossoscolecidae, Microdrili), location of last hearts two segments in front of ovarian metamere (Ocnerodrilidae[5]), lateral hearts (Lumbricidae), location of male pores in front of female pores, elongate, posteriorly directed seminal vesicles and ovisacs, yolky ova and a one-cell-layered clitellum (Microdrili). Dissimilarities, on the contrary, are significant and as important as those which mark off Asiatic moniligastrids from other earthworms. In these circumstances common location of extra-esophageal trunks lateral to the hearts and the presence of a relatively thick layer of non-fibrous material between circular and longitudinal muscles, can scarcely be regarded as evidence for any close relationships to Asiatic moniligastrids. Resemblances to *Desmogaster*, in location of spermathecal, male, and female pores, are superficial and of no significance.

What then are the affinities of *Syngenodrilus*? Yolky ova, a one-cell-layered clitellum, and posteriorly elongated seminal vesicles necessitate consideration of relationships with the Microdrili. Evidence from distribution and morphology (note especially segmental location of male and female pores and of spermathecae in viii and ix) point to the Alluroididae as deserving of most consideration. This family is monogeneric and hence recognition of family characteristics (apart from those merely of generic significance) is difficult. There is, however, no necessity for regarding absence of nephridia in a few anterior segments and presence of a gizzard as of sufficient importance to warrant exclusion of *Syngenodrilus*. Similarly proandry need not be regarded as of more than (if even of) generic value. After inclusion of *Syngenodrilus* the Alluroididae can still be defined as follows: Setae lumbricine. Male pores on or just behind 12/13, female pores on xiv, spermathecal pores on or close to 7/8 and (or) 8/9. Digestive system without appendages (or typhlosole?). Meganephric. Metagynous,[6] mature ova large and yolky, clitellum one-cell-layered. Spermathecae simple, without diverticula. A decision as to the necessity for retention of the subfamily Syngenodrilinae, of course, must be left to the future although some justification for recognition of two subfamilies at present appears to be provided by the male genital terminalia and possibly gizzards; Alluroidinae, male ducts opening to exterior through atria, no gizzards; Syngenodrilinae, male ducts opening to exterior independent of prostates, gizzards present. The author, because of lack of literature and material, is not in a position to determine whether similarities between *Syngenodrilus* and *Alluroides* are as unimportant as those between *Syngenodrilus* and *Desmogaster* and the suggestions advanced above must be left for consideration by those who are not so handicapped.

When further syngenodrilin material becomes available the histology of the "prostates" should be investigated. Superficially these structures resemble the tubular prostates of certain megascolecid genera. It should be noted that the "prostates" of *Syngenodrilus* are not united with the male deferent ducts as in *Plutellus* and other megascolecids, are not closely associated with the male deferent ducts as in certain diplotremids, acanthodrilids, and ocnerodrilids, nor do they open into seminal grooves as in other acanthodrilids and ocnerodrilids. Similarity appears to be rather with the "prostatelike" glands of *Sparganophilus* where the glands may be present in some species and not in others, with even some intraspecific variation as to presence and absence. Presence in *Syngenodrilus* of structures similar to the prostatelike glands of *Sparganophilus* need not then be an argument against inclusion of *Syngenodrilus* in the Alluroididae. More important seems to be the question as to whether absence of the alluroidid type of "atrial prostate" (apparently more like the capsular prostates of the Moniligastridae and the euprostates of the Eudrilidae) is sufficient reason for exclusion of the genus. This type of prostate has been regarded as an enlarged and modified ectal portion of the vas deferens.

[5] Other similarities to the Ocnerodrilidae, absence of typhlosole, dorsal pores (?) and spermathecal diverticula, an anterior intestinal origin in xii (?), and possibly tubular prostates.

[6] Stephenson, 1930, p. 806, locates the female pores on xiv but the ovaries in xii. Possibly the latter is a misprint for xiii, since length of oviducts, as a rule, is less than that of a single segment.

ZOOLOGY.—*Additional observations on the oligochaete genus* Syngenodrilus.[1] GRACE E. PICKFORD, Osborn Zoological Laboratory and Bingham Oceanographic Laboratory, Yale University. (Communicated by WALDO L. SCHMITT.)

In the spring of 1945, in ignorance of the fact that Dr. G. E. Gates had included observations on the type of *Syngenodrilus* in an unpublished article entitled *On the Moniligastridae and phylogeny of the Oligochaeta*, the present author made an independent study of the specimen. Meanwhile, through correspondence with Dr. Gates, it was discovered that his article had been prepared for publication and that a carbon copy was available in the United States, although the original had been lost at the time of the Japanese invasion of Burma. After consultation with Dr. Waldo L. Schmitt, to whom my best thanks are due for his cooperation, and with the permission of Dr. Gates, it was decided to arrange for immediate publication of the first part of his article, that dealing with *Syngenodrilus*, in slightly condensed form together with some additional observations. The latter are presented herewith, in the form of a separate article, since there are certain discrepancies between the two accounts and the author did not feel that it would be right to introduce qualifications or corrections, based on his own opinion, into the text of Dr. Gates's account.

ADDITIONAL OBSERVATIONS

(1) *The sections.* The sections are mounted on 10 slides, labeled *a* to *j*, and except on four of these (*g* to *j*), where the gizzard region caused trouble, the series is reasonably complete and in good condition. The original description of Smith and Green, based largely on these sections, is remarkably accurate. Several of the original drawings are composite, but it is always possible to identify the actual sections from which they were made. No mistakes were discovered. On the other hand, as Gates has pointed out, no further light could be obtained regarding some of the points that were left unsettled in the original description; in particular, the relations of the septa in the region of the testis sacs must remain obscure until new material can be examined. The relationships of the genital pores to the setae can be reconstructed without difficulty, and there is no doubt that the original account is essentially correct. The male pore appears on slide *a*, on the sixteenth and seventeenth sections from the beginning; the spermathecal pores are on the second row on slide *b*; the prostates are on slide *d*; the female pore is on slide *e*.

The gizzard has a cuticular lining which ceases in the dilated, thin-walled, croplike region which follows. The position of the first intestinal segment cannot be determined.

(2) *The specimen.* Dorsal pores could not be seen either on the specimen or on the sections. The clitellum does not include the anterior third of segment xi but extends from 2/3 xi to xvi inclusive and is ring-shaped, as stated by Smith and Green. The male pore is clearly visible with good illumination and is situated in intersegmental furrow 12/13, about 3/5 *bc* lateral to setal line *b*; this observation conflicts with that of Gates but is in accordance with the evidence of the sections. The female pore is less conspicuous but can be seen lateral to seta *b* of segment xiv; this statement is not in agreement with that of Gates who found the female pores in front of seta *a*; on the sections, the oviduct is seen to open lateral to the *b* seta. The prostatic pores cannot be identified with certainty on the specimen, although clearly visible on the sections. Gates has described the position of the spermathecal pores, also very difficult to see, and their location is in agreement with that expected from a study of the sections.

A rectangular area resembling a copulatory band, which was not observed by Smith and Green or by Gates, occupies a region of the clitellum that is bounded above and below by setal lines *cd* and *ab*, respectively; this area is delimited anteriorly by intersegmental furrow 11/12 and posteriorly by the *ab* setae of segment xiv. The setae of the clitellar segments, difficult to see on the specimen, can readily be identified on the sections.

[1] Received October 24, 1945. See note to Dr. Gates's companion paper herein, p. 393.

Several attempts were made to obtain a sigmoid seta for examination, but unfortunately all that were removed proved to be broken at the distal extremity, no doubt as the result of much handling of the specimen. On the sections the ventral setae of segments xiv, xv, and xvi are preserved unbroken and in a favorable position for study; however, examination, even with an oil immersion apochromat, failed to reveal any definite evidence of ornamentation, although some faint surface markings of an obscure nature were observed. The refractive index of damar is unsuitable for the study of delicate setal ornamentation and the matter cannot be considered settled.

Confirming statements of Gates, the gizzards, shown in Smith and Green's fig. 2, have dropped out of the specimen and could not be found; there is no trace of calciferous glands either on the specimen or on the sections, and the intestine is without typhlosole. *Syngenodrilus* is holonephric; nephridia from segments xlii and xliii were removed and mounted, the terminal duct has a pear-shaped dilation at its ectal end.

DISCUSSION

Gates's observations are, with minor exceptions, in close agreement with those of the present author, and there is no doubt that the general pattern of his conclusions must be supported. Two points may be added to his discussion of the problem: On the one hand, the nephridia are quite unlike those of the moniligastrid genus *Drawida*, in which there is a remarkable blind sac extending dorsally from the ectal duct. On the other hand, the suspicions raised in his footnote 6 regarding the position of the ovaries in *Alluroides* are fully justified. In the original description of *A. pordagei* Beddard[2] stated that the ovaries were in segment xiii but later in the same article, in the formal diagnosis of the new genus, the ovaries are said to be in segment xii. Evidently subsequent diagnoses by Michaelsen[3,4] and Stephenson[5] have perpetrated this error, which stemmed from a misprint in the original article, although Beddard[6] himself corrected the generic description. Stephenson attempted an interpretation of the *Syngenodrilus* testis sacs as condensed segments and obtained, by a process of theoretical expansion, the following arrangement of the gonads: testes in x and xii, ovaries in xiv. Gates has pointed out that this interpretation is very improbable and reexamination of the material gives no support to such a theory.

Syngenodrilus can not be included in the Moniligastridae, and it is clear that it has strong affinities with the Alluroididae. Gates has suggested that it might even be placed within the latter family, but there are important differences that would appear to necessitate the recognition of two distinct subfamilies, Alluroidinae and Syngenodrilinae. In view of the inadequacy of our present knowledge of the Alluroididae,[7] a family whose characters will probably be clarified by the discovery of new species and genera, it seems preferable to retain the family Syngenodrilidae, while recognizing that future discoveries may bridge the gap that appears to exist at the present time. Michaelsen[4] proposed that the families Phreoryctidae, Alluroididae, Syngenodrilidae, and Moniligastridae should be placed together in the family-group Phreoryctina. It seems to the writer that there is much to be said in favor of such an arrangement; however, the Alluroididae and Syngenodrilidae differ from Haplotaxidae (=Phreoryctidae) on the one hand, and from Moniligastridae on the other hand, in a number of important respects, of which the most significant is the backward migration of the male duct which opens to the exterior at 12/13 or on segment xiii. As Gates has pointed out, the Syngenodrilidae differ from the Alluroididae in the possession of a well-developed, double, esophageal gizzard, in having simple *Sparganophilus*-like prostatic glands which are not related to the male opening, and in the absence of a moniligastrid-like atrium at the ectal end of the vas deferens.

[2] F. Beddard, Quart. Journ. Micr. Sci. **36**: 244–252. 1894.

[3] W. Michaelsen, *Das Tierreich, Oligochaeta.* 1900.

[4] W. Michaelsen, *Oligochaeta, in* Kükenthal and Krumbach's "Handbuch der Zoologie." 1928.

[5] J. Stephenson, *The Oligochaeta.* Oxford, 1930.

[6] F. Beddard, *A monograph of the order Oligochaeta.* Oxford, 1895.

[7] The Alluroididae have hitherto been considered to be a purely African family, but the existence of an undescribed species in the Argentine was noted by L. Cernosvitov (Mem. Soc. Zool. Tchecoslovaque Prague **3**, 1936). Dr. Cernosvitov informs me, *in litt.*, that this form is very close to the already known species but has enormous penial setae.

A formal redefinition of the family follows; of necessity it includes some characters which may, with the discovery of new forms, prove to be of less than family significance.

Family SYNGENODRILIDAE Michaelsen (1928)

Sigmoid setae single-pointed, eight per segment, in two ventral and two lateral bundles. Dorsal pores wanting. Clitellum in a single layer of cells, in the region of the male and female pores. One pair of male pores at 12/13; one pair of female pores on xiv; two pairs of spermathecal pores in 7/8 and 8/9. Two esophageal gizzards in viii and ix; no calciferous glands; intestine without typhlosole. Six pairs of lateral hearts in vi to xi (?), those of vi and vii communicating with lateral "extra-esophageal" vessels. One pair of holonephridia per segment; ectal nephridial duct with a dilated vesicle. Holandric, two pairs of testes and spermiducal funnels in x and xi, respectively, enclosed in testis sacs; paired seminal vesicles depending backward from 10/11, enclosed within the ovisacs. One pair of ovaries in xiii; ovisacs depending backwards from 13/14 into xx; eggs yolky. Three pairs of simple prostatic glands opening on xi, xii, and xiii just lateral to the *b* setae, not associated with the male pores. Penial and genital setae lacking. Spermathecae without diverticula. One genus: *Syngenodrilus;* monotypic, *S. lamuensis* Smith and Green.

ICHTHYOLOGY.—*Notes on fishes in the Zoological Museum of Stanford University: XX, New fishes from China and India, a new genus, and a new Indian record.*[1] ALBERT W. C. T. HERRE, Stanford University. (Communicated by HERBERT FRIEDMANN.)

This paper terminates a series begun in 1934. The first paper was a brief account of the fishes of my 1931 Philippine expedition and was published by me in Hong Kong. The series continued with accounts of new or rare fishes collected by me in various parts of the world and was published in various journals in this country.

South China abounds with a great variety of fishes, both marine and fresh water, which even yet are imperfectly known. This is particularly true of the region from Hong Kong southward, which has never been explored by an ichthyologist. Ten days were spent in Hong Kong during March 1941, and many rare cold-blooded vertebrates were secured. Two trips were made to the New Territory to study the fish-pond industry and to do a little collecting. A new species of *Vaimosa* was obtained and is here presented. This genus is rich in species in the regions bordering on the South China Sea, including the adjacent islands.

The coastal waters of India have never been adequately explored for littoral fishes; this is true alike for the coral reefs of the extreme south and the long reaches of the Coromandel and Malabar coasts. Investigation of the coastal waters, including brackish lagoons and the river mouths, should give us a greatly extended knowledge of fish distribution, as well as add many fishes to the known Indian fauna, some new species, and others known only from more or less remote regions. In this paper is recorded a fish hitherto known only from a single Philippine example, but really common in the Bay of Bengal. In addition, two gobies, an eleotrid, and a scorpaenid are presented as new. I have no doubt that collecting in the Andaman Islands would add 200 species to the known Indian fish fauna.

The labors of the competent staff of the Indian Zoological Survey, particularly of Dr. S. L. Hora, have added greatly to our knowledge of the fresh-water fishes of India, and as a result those of northern and central India are fairly well known. Much less has been done on the fishes of the streams of south India, and it is to be expected that new fishes should be found in that region, particularly in the hill streams. I have already described a new catfish from the Anamallai Hills, and now present a member of the genus *Homaloptera* from the same locality. Dr. Hora has already described two homalopterid fishes from Travancore and Mysore. One of them, *Bhavania australis,* was described by Jerdon

[1] Received July 2, 1945.

in 1848 under the name of *Platycara australis*. Because of its peculiarities Dr. Hora created the genus *Bhavania* for it and extended our knowledge of the fish. The other homalopterid, *Travancoria jonesi*, was first described by Dr. Hora.

The Puthutotam Estate in the Anamallai Hills, where I collected the new *Homaloptera*, is not far from the region in Travancore where both *Bhavania australis* and *Travancoria jonesi* occur, although separated by forest-clad mountains. That the fauna of the two areas is much the same is shown by the fishes common to their streams; one of them, *Travancoria jonesi*, which I also collected at the Puthutotam Estate, is of special interest as showing that it is not confined to the streams at the foot of the Travancore mountains.

The members of the genus *Homaloptera* occur in the East Indies, Malaya, and Burma, and apparently this is the first time that a member of the genus has been found in South India. The earlier accounts of *Homaloptera* from south India all refer to *Bhavania australis*. Burma is the nearest region to south India from which *Homaloptera* has been known hitherto. It is therefore a matter of much interest to students of geographical distribution to find a species of *Homaloptera* in the mountain streams of south India. It has been known for a good while that many of the fishes of south Indian streams have their closest relatives in, or are identical with, species in the streams of Malaya. Dr. Hora has paid much attention to the problems involved, and I agree with his theory that the homalopterid fishes and other torrential dwellers reached south India by migrating along the Satpura Trend.

Lengths given are always the standard length.

Family Homalopteridae

Genus **Homaloptera** Van Hasselt

Homaloptera montana, n. sp.

Dorsal II–6; anal I–5; pectoral VI–8; ventral, II–7 on one side, III–6 on the other side; lateral line about 72; transverse series of scales 16–1–12.

The depth is 9.6, the head 4.8, the pectoral 3.8 times in the length; the caudal and ventral equal the head. The eye is 4.3, the snout 2, the postorbital length of the head 2.5 times in the head; the flat interorbital is a little more than the eye; the least depth of the caudal peduncle is twice in its own length.

The form is slender, the posterior half laterally compressed, the dorsal profile little elevated, the eyes dorsolateral; the snout descends steeply, with rather flat tip; the arched mouth is small, the barbels small and inconspicuous. The dorsal origin is well behind the ventral origin and behind the middle of the length, the distance from the tip of the snout to the dorsal being 52 percent, to the ventral origin 43 percent, of the total length; stated differently, the ventral origin is opposite the nineteenth tubule of the lateral line, the dorsal origin opposite the twenty-sixth. The tip of the pectoral touches the ventral origin when depressed, but the ventral falls short of the anus, which is noticeably in advance of the anal origin. The caudal is nearly truncate, the corners little projecting. The head and entire lower surface back to a little behind the ventral base are naked.

The color in alcohol is brown, the underside yellowish; 10 short dark brown bars across the back, but not extending down to the lateral line; a poorly defined dark longitudinal stripe below the lateral line from the eye to the caudal base; top of the head very dark brown; a blackish-brown spot on the ventral base; caudal with a blackish blotch on its base and another near its tip; other fins all clear.

Described from the type and only specimen, 48 mm long, which I took from a brook on the Puthutotam Estate in the Anamallai Hills at about 3,600 feet altitude, Valaparai Postoffice, Madras Presidency, South India.

Family Scorpaenidae

Genus **Scorpaena** Linnaeus

Scorpaena lacto-maculata, n. sp.

Dorsal XI–I–9; anal III–5; about 60 scales in a longitudinal row above the lateral line; 25 tubulated scales in lateral line; about 38 scales in transverse series, 8 from the sixth dorsal spine to the lateral line.

Depth 5.5, caudal 6.9, head 4.18, pectoral 5.8, ventral 7.4 times in the length. The eye is 5.5 times in the head and is a little more than the interorbital breadth; snout 3.4 times in

head. The longest dorsal spine is approximately a third of the head; the longest dorsal rays equal the second anal spine, 2.6 times in the head; the third anal spine is as long as the second but is much slenderer; longest anal ray is half as long as the head. The 6 upper pectoral rays are divided, the 12 lower ones simple.

Interorbital deeply concave, the prominent supraorbital ridge with 3 spines, followed by a large spine behind the ridge; a spine on each side of the prominent hump on the snout; 2 spines, very close together, on each side of the nuchal area; behind the middle of the eye is a group of small spines, followed by a row of 3 rather widely spaced spines; 2 opercular spines; 4 spines on the bony stay below the eye and a row of spines on the hind margin of the preopercle; a spine on the shoulder girdle above the pectoral base. Head scaleless or with a very few small scales on the opercular flap; many tentacles, often large and fringed, on the head, between or on spines, on the broad maxilla and overhanging it, on the chin and along the rami of the lower jaw, on the cheeks, and 2 or 3 small ones on the upper part of the eye ball; simple flaps along the lateral line and on numerous scales on the sides of the body. The large mouth is oblique, the maxilla extending beyond the hind margin of the eye; no palatine teeth.

The color in alcohol is freckled reddish brown, with 2 or 3 bands of darker brown extending across fins and body; just above the lateral line and beneath the ninth dorsal spine is a circular milky spot, larger than the pupil; beneath the eye is a similar but much smaller spot; at the hind end of the soft dorsal base is a larger milky spot, partly on the fin but mostly on the body; the numerous tentacles or flaps below the lateral line are also milky white; these spots and tentacles were probably opalescent in life. The pectorals, dorsal, and caudal have broad pale or white, but not milky-white, cross bands.

Described from two specimens taken from "shallow water near Bombay," India, each of them 222 mm in length. The type is in the Indian Museum, the paratype in the Natural History Museum of Stanford University.

Genus **Brachypterois** Fowler

Brachypterois serrulifer Fowler

Brachypterois serrulifer Fowler, Proc. U. S. Nat. Mus. **85**: 79, fig. 35. 1938.

This fine scorpaenid was described from a single specimen, dredged 8.4 miles off San Fernando Point, on the west coast of Luzon, Philippine Islands. To Fowler's description I can add that the pectorals are black and that the ventral rays are also black except basally.

This species must be rather common in the northern end of the Bay of Bengal. One specimen, 73 mm long, was taken by the Bengal Fisheries Department on the Arakan coast. Another of 65 mm was caught off Gopalpur, Orissa. Fifteen examples from 43 to 80 mm in length were dredged at the mouth of the Hugli River by the *Lady Fraser*.

Dorsal XII–I–10; anal III–5; pectoral 16.

Family Eleotridae

Genus **Hypseleotris** Gill

Hypseleotris raji, n. sp.

Dorsal VI–I–8; anal I–7; scales ctenoid, 28 in lateral series plus 2 on caudal base, 9 in transverse series; 12 predorsal scales.

The body is moderately plump and stout, the dorsal profile well arched, descending steeply from the dorsal origin to the tip of the snout; the depth and caudal are equal, $4\frac{1}{8}$, the head 3 times in the length; the large eye is in the anterior half of the head, dorsolateral, scarcely larger than the broad snout, 4 times in the head; the interorbital is 1.35 times in the eye; the postorbital is slightly more than half the head. The fins are all low, the longest dorsal spine 3.14 times in the head or 9.4 in the length; the last ray of the second dorsal is longest, 2.44 in the head or 7.33 times in the length; the ultimate and penultimate anal rays are longest, 2.2 in the head or 6.6 in the length; the pectoral extends above the anal, 3.66 in the length; the ventrals reach the anal, four and an eighth in the length. All scales are ctenoid, those on the cheeks very small; anal papilla thin, slender, blunt, inconspicuous.

The ground color in alcohol is pale tan, with 4 double cross bands of dark brown, the first over the nape, the last on the caudal peduncle; the ground color appears as pale bands and rows of spots through the cross bands; a blackish-brown cross bar on the caudal base; dark brown bands from the eye on the snout and across the cheek, at least two of them continuing on the under side of the head to meet similar bands from the other eye. The first dorsal is largely black; the second dorsal has a blackish

band basally, then a clear band, the outer third or half blackish; the anal and ventrals have black rays with dark or blackish membranes; the pectoral base has a large dark brown spot, the fin clear; the caudal has 4 circular black spots on its base.

The type and only specimen is a male 33 mm long, taken from the Adyar River, Madras. Named for Dr. B. Sundara Raj, former director of fisheries for the Madras Presidency, who did so much to make my visit to Madras successful.

Family Gobiidae

Orissagobius, n. gen.

Dorsal VI–I–8 or 9; anal I–8 or 9; scales large, finely ctenoid, 22 to 24 in longitudinal, 6 in transverse series; a narrow naked predorsal strip, the nape otherwise covered with cycloid scales almost to the eyes; preopercle covered with large deciduous cycloid scales; opercle naked except for one or two cycloid scales at the upper inner corner. Eye large, in anterior half of head, interorbital very narrow; snout short, two-thirds or less of eye; mouth strongly oblique, each jaw with an outer row of stout, enlarged, sharp-pointed and curved teeth, followed by 3 rows of minute teeth, at least the outer rows of teeth visible when the mouth is closed; tongue large, fleshy, truncate or slightly notched; gill opening extending forward to beneath the hind margin of the preoperculum. Fins all elongate, the upper rays of the caudal greatly extended, some specimens with the caudal half the standard length; the antepenultimate ray of the second dorsal longest, equal to or longer than the head, the same ray in the anal nearly as long; pectoral about four-fifths of the head, its base long and fleshy; no free pectoral rays; ventrals large, with a well developed frenum, free from abdomen. Tissues of this fish fragile, showing that it lives in rather deep water.

Type of genus: *Orissagobius cometes* (Alcock). Known only from the Ganjam coast, Orissa, India. Dredged from depths of a little more or less than 100 fathoms, by the S.S. *Investigator*, of the Indian Marine Survey. Eight specimens, 61 to 73 mm in length, were examined.

Genus **Macgregorella** Seale

Macgregorella indica, n. sp.

Dorsal VI–I–9; anal I–8; predorsal scales 4; about 50 longitudinal scales, 14 in transverse series; the head is entirely naked.

The depth equals the rounded caudal, 6 times in the length; the large broad flat head is 3.47 in the length, its depth 1.6 times in its breadth, which is 1.28 in its own length; the broad blunt snout is 3.95 times in the head; the small eyes are dorsolateral and in the anterior half of the head, 7.3 in the head and 1.38 times in the broad interorbital; the teeth are typical of the genus.

The snout, sides, and underparts of the head are marked by numerous rows of sensory papillae, some of them elongated and somewhat resembling barbels, especially on the chin and underside of the head. A large pore before the inner margin of each eye, and a transverse row of 4 large pores behind the eyes and interorbital space. The dorsals are low, the height of the first 4.75 in the head; the posterior rays of the second dorsal and anal are longest, 8.25 times in the length or 2.375 in the head; the broad pectoral is eight-ninths of the head, 3.88 in the length; the ventrals are typical goby ventrals with a strong and well developed frenum, and are contained a trifle over 5 times in the length or 1.46 in the head.

The color in alcohol is pale reddish brown with 4 broad conspicuous dark reddish-brown cross bands on the trunk and a narrow stripe of the same color on the caudal base; the first band extends upon the pectoral on both its inner and outer faces; between the cross bands are blotches and streaks of reddish brown; the second cross band extends upon the first dorsal, the third and fourth upon the second dorsal; the anal and caudal are obscurely barred by brown.

Described from the type and only specimen, 33 mm long, taken from coral at Krusadai Island in the Gulf of Manaar, Pamban District, Madras Presidency, South India. Such specimens as this show the fallacy of placing all gobies with ridges of papillae on the head, and the body barred with brown, in the genus *Callogobius*, which is marked by weak ventrals with a very slight fragile frenum. In spite of Kouman's assertion, *Macgregorella* is a good genus.

Genus **Vaimosa** Jordan and Seale

Vaimosa adyari, n. sp.

Dorsal VI–I–7; anal I–7; scales in lateral se-

ries 26, plus 3 on the caudal base, in transverse series 8; predorsal scales 7, the anterior one much enlarged and projecting forward between posterior part of the eyes; opercular scales 6.

The compact body is little compressed, the dorsal profile almost horizontal, the ventral profile slightly curved; the depth is 5 to 5.25, the head 3.8, the caudal 2.8, the pectoral 3.33 to 3.8, the ventral 4.2 times in the length. The snout is broad, blunt, convex, 5.2 to 5.5 times in the head; the eye is moderately large, lateral, in the anterior half of the head, in which it goes 3.4 times; the postorbital is slightly longer than the eye and snout together; the narrow interorbital is not more than a fourth of the eye; the oblique mouth is subterminal, the lower jaw weak, the maxillary extending beneath the anterior margin of the eye, or a little beyond; the vertical fins are small, the dorsals rather far apart, the second and third spines of the first dorsal longest, 2.1 or 2.2 in the head, 8 times or a little more in the length; the second dorsal and anal are of equal height, both falling far short of the caudal base when depressed, six and two-thirds or 7 times in the length; the pectoral equals or slightly exceeds the head, 3.5 to 3.8 in the length; the ventrals are broadly pointed, with strong well developed frenum, 1.1 in the head; the least depth of the caudal peduncle is about 1.7 times in its own length; the small inconspicuous anal papilla is slender and pointed in males.

The color in alcohol is very pale yellowish, with 5 short brown dorsal cross bands, the first predorsal, the second under the first dorsal, the next two under the second dorsal, and the fifth on the caudal peduncle; along the middle of the side are 5 oblong brown spots, the last on the caudal base, with another spot below it; on the sides are also scattered flecks of brown; a spot on the pectoral base, one on the opercle, and one below the eye; the posterior half of the first dorsal is black; the second dorsal has 3 cross rows of black or brown spots, the caudal 5 irregular cross rows of brown spots; some of the rays of the anal and ventrals are dotted with black and there are 3 to 5 black spots on the median line of the body between the anal origin and the caudal base.

Described from 2 male specimens, the type 21 mm long and paratype 20 mm, and a juvenile specimen 15.5 mm in length. They were taken by me on January 4, 1941, from the Adyar River, opposite "The Anchorage," the residence of Dr. B. Sundara Raj, former director of fisheries of the Madras Presidency. This is not far from the Bay of Bengal, and the Adyar River is more or less brackish at this point.

Vaimosa crassa, n. sp.

Dorsal VI–I–7; anal I–8; scales in longitudinal series 36, plus 3 or more on the caudal base, 12 in transverse series; predorsal scales 15, extending through the interorbital space to the front margin of the eyes; preopercular scales 9 or 10.

Body thick, plump, only the posterior third being laterally compressed; dorsal outline very slightly arched, nearly horizontal; ventral profile gently arched; the head is contained 3.7 to 3.8, the depth 4.55 to 4.7, the short rounded caudal 4.85 to 5.14 times in the length; the large eye equals or exceeds slightly the length of the snout, 3.8 times in the head; the postorbital is a trifle less than the eye and snout together; the broad interorbital equals or slightly exceeds the eye; the wide mouth is inferior, the maxillary extending beneath the front third of the eye, or almost to its middle; in males the maxillary probably extends beyond the eye. The fins are all small, the vertical fins low, the second spine of the first dorsal 2.2 to 2.6 in the head or 8.3 to 9.5 times in the length, the dorsals far apart; the height of the second dorsal is approximately 2 to 2.4 times in the head or 7.5 to 8.9 in the length; the longest anal ray is 2.3 to 2.4 in the head or 8.9 to 9 times in the length; the anal and second dorsal fall far short of the caudal base when depressed; the short rounded pectoral is 1.3 to 1.4 in the head or 4.85 to 5.5 times in the length; the ventral extends but half way to the anal papilla, 1.85 or 1.9 in the head and 6.8 to 7.2 in the length; the least depth of the caudal peduncle is 1.4 times in its own length. Females have a short, broad, bluntly rounded, and inconspicuous anal papilla.

Alcoholic specimens are marked by broad dark brown diagonal bands inclined forward and downward, with narrow and very pale tan stripes between; one specimen has the head and body before the first dorsal all brown, mottled with dusky. On the middle of the front margin of the opercle is a blackish spot, with a dark stripe descending from it to the underside of the head; a black spot near the upper end of the

caudal base; the first dorsal is blackish, the second dorsal and anal more or less dusky; the other fins are colorless.

Here described from two female specimens, the type 34 mm long. and paratype 36 mm long They were taken from a brook near Un Long, New Territory, Hong Kong. No other specimens were secured.

APPEAL TO AMERICAN SCIENTISTS

Many scientists and their families are enduring severe hardships in occupied countries. We, the undersigned, wives of American scientists, want to help these innocent victims of the Axis. We suggest the desirability of supplementing the work of the established relief agencies by sending gift packages of clothing and food directly to individual scientists and their families. Some of us have already sent packages to friends whose present addresses are known, and the acknowledgments we have received leave no doubt of the urgent need which these packages are helping to meet. Used clothing and shoes are genuinely appreciated.

American scientists who would like to send packages to colleagues in the occupied countries may obtain names and present addresses from the Secretary of this group. It is suggested that you indicate the country of your greatest interest and the ages of the children for which you can supply clothing.

A package sent *now* is worth six sent next spring.

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EDITH O. HENDRICKS
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